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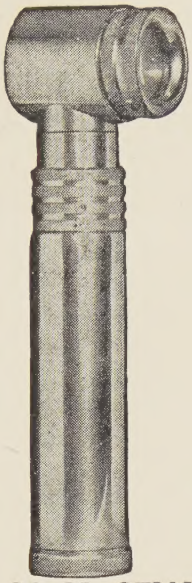

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The Journal of THE AUSTRALIAN INSTITUTE OF AGRICULTURAL SCIENCE

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ARTICLES

GENETICS IN AUSTRALIAN AGRICULTURE

By A. L. HAGEDOORN

In writing a report of my impressions of my tour through Australia and on suggestions for future work in the interests of Australian agriculture, two subjects stand out which I will treat separately:

A. My ideas about the present state of applied and pure genetics in Australia; and

B. My thoughts about the best way to take advantage of genetics in the future development of Australian agriculture.

It will not be possible to keep these two subjects wholly separate, of course, but on the whole this report will be more useful if I make the attempt.

A. The Present State of Genetics and Applied Genetics in Australia in its Relation to Methods of Plant Breeding and Animal Breeding

In a general way a few impressions stand out distinctly. In the first place, comparing Australia with England and Western Europe on the one hand and with the U.S.A. on the other, I was particularly struck by the fact that the agriculturists were very much less hidebound over here than in Western Europe, and that especially the men in charge of co-operation with breeders were far less opinionated and conservative. These men on the whole I found to be rather too diffident than too cocksure; they were very receptive and wide-awake.

I found the experiment station work of a high grade in most cases, and when I compared it with experiment station work in the U.S.A., I had the impression that the men in charge had a very much better understanding of the work of the breeders and farmers, so that their work did not tend (as it so often does in the States) to be of a high scientific standard, while being of doubtful applicability. This may partly have been due to the smallness of the experiment stations and the paucity of available men, and it seems quite possible that those advantages will tend to disappear when there are trained men available and when the "scientific" standard of the workers is raised.

I was very favourably struck by the general attitude of the breeders in Australia. Here again, I found a minimum of conservatism, and an excellent grasp of the fact that the plants and the animals must fit into profitable schemes of agriculture. Only in a few isolated instances did I meet with systems of breeding in animals where the breeders were so much concerned with meeting the immediate demand of their customers that they had lost sight of the ultimate practical use of

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Dr. A. L. HAGEDOORN, world-famous geneticist, of Leyden University, Holland, visited Australia last year and while here lectured to animal breeders in all States. Dr. Hagedoorn has a flair for explaining the practical application of genetics to the animal breeder in simple language and his visit, therefore, created widespread interest amongst stock breeders. He is at present in South Africa where he is carrying out a lecture tour in that country.

After Dr. Hagedoorn's visit to Australia, he prepared some informal comments on the present state of Australian research and application in genetics and plant and animal breeding. It has been suggested that these views, which were forwarded to the Chairman of C.S.I.R.O., may be of general interest and Dr. Clunies Ross has kindly made them available for publication.

the breeds sponsored. To a certain extent, this must be due to the fact that generally much larger numbers of livestock were available to each breeder than is the case in such countries as England.

It stands to reason that I was very much interested in the work of those breeders who have been practising what I have so long preached—namely, the reduction of the potential variability of their strains by a combination of progeny testing and inbreeding (nucleus-schemes). I found that several successful breeders, both in sheep and in poultry, had been working along those lines, often with very excellent results, mainly in reducing the variability downwards (bringing down culling percentages). In a few instances I was able to find just where the fault lay in cases where breeders had been less successful. But all along the line I found that they had a very good grasp of the principles involved and that they had worked out practical solutions of apparent snags.

I found that the breeders, especially the animal breeders, had mostly obtained their genetical insight directly from the literature, mostly from such books as Lush's and my own, and very rarely from local sources of genetical investigations. Although I must concede that in the immediate future this does not matter much, in the long run I should think that it is highly desirable that genetics should be taught in Australia at many universities and colleges (see section B).

I had expected (and many others had expected) that during my tour there would have been quite a lot of antagonism from the side of the pedigree breeders and from the adherents of the system of judging the animals at the shows according to their phenotype. This antagonism, however, was not very apparent. There were, I think, several reasons for this. Most of the breeders had read my book, and my attitude did not come as a surprise. In the second place, I made it clear from the very first that I think the breed societies have an important role to play in the breeding of good animals for Australia. Also, the old-fashioned shows have passed their zenith and this is better realised in Australia than anywhere else. The breed societies and their officers were very co-operative and at official dinners and annual meetings the officials were always ready to discuss methods of improving breeding policy in a sincere and open way.

Poultry and Sheep

Especially in the breeding of poultry and of sheep, the work of the Australian breeders can bear comparison with that of the American and European breeders very well. Both the breeders of White Leghorns and of Merino sheep are fast bringing down culling percentages by adequate methods. Some of the experimental stations, notably Trangie and Seven Hills, do work of the very greatest practical and scientific importance.

Dairy Cattle

In the breeding of dairy cattle, enormous difficulties exist, as elsewhere. The greatest single difficulty lies in the fact that very large herds of a sufficient size to permit the testing of enough young bulls do not exist. In this case, however, there is one point in which Australia has an advantage over such countries as England. The founding of artificial insemination centres is still in its infancy. And as a result of my tour and many discussions with men of the Departments of Agriculture, I am now firmly convinced that an artificial insemination centre can easily be made into a co-operative cattle breeding nucleus, provided the whole scheme is firmly kept in competent hands, while all heifers are always milk tested and registered so that the whole establishment can become a nucleus for the production of purebred high quality progeny tested young bulls. Where herd testing is not insisted upon (as in the British artificial insemination centres), the greatest future quality of this work is

lost. I may add that personally this solution alone of the difficulty of breeding dairy cattle rationally made it well worth my while coming over to Australia.

Beef Cattle

I found the breeding of beef cattle in Australia rather unsatisfactory. Partly this is due, I think, to the fact that the system of showing beef bulls (young bulls that have been raised on nurse-cows and eggs winning the prizes) has made it extremely difficult to use honest, rational standards of quality. And partly this is certainly due to the general unsuitability of North-western European animal breeds for Australian climatic conditions. I did not see very much of the experiments destined to improve beef cattle for station conditions by means of heightening their variability by means of Zebu crosses. I am certain that this would be one solution. I am also sure that if the work is done in such a way that the advantage of the first crosses is added to the genotype of, say, the Hereford, by carefully controlled and many generations of repeated backcrosses (as is probably intended), it might work out very well. The danger would, of course, lie in the material getting out of hand, so that halfbred bulls might breed and it might, under those conditions, result in hopeless mongrelisation. If this work is restricted to well-fenced paddocks and no one is allowed to use crossbred bulls for at least six generations, it might work out very well.

Importation of Plants and Animals

This is the place to state my opinions upon the importation of plants and animals into Australia. With plants it is sufficiently recognised that it is necessary to have them adapted to Australian climatic conditions (length of day, insolation, rainfall) before they can be of any advantage. Most important Australian agricultural plants have been made locally by a system of selection after crossbreeding, and the few others have been imported from regions where the climate is closely similar.

With domestic animals, breeders have tried to adapt animals from regions that were wholly different from the Australian ones, with very few exceptions. In sheep, there is an enormous difference between the Merino and the British breeds. The Merino was imported from the Mediterranean, crossbreeding has modified it, but the bulk of the stock was adapted to conditions of high insolation and low rainfall before they arrived here.

The British breeds have never become as well adapted. There are two reasons. They came from very different climatic conditions in the first place, and repeated importations of show-winning rams from Britain have handicapped those breeds. They have never had a chance to become well adapted. In fact, not one of those breeds has any considerable importance in Australia by itself alone. The two species best adapted to Australian conditions and of the very greatest agricultural importance — the subterranean clover and the Merino—were both imported from Mediterranean countries. Although I fully realise the enormous difficulties involved (they could be circumvented, I think, by a Commonwealth system of island quarantine), I would certainly recommend sending a committee to Spain, Southern France and perhaps to Italy, to study and eventually import some of the splendid muttonsheep, beef cattle and dairy cattle of those regions.

Plant Breeding

Plant breeding in Australia, in as far as I saw anything of it, appeared to be on a very high plane. There is, it seems to me, an enormous scope in the breeding of such plants as maize and soybeans, perhaps in legumes and pasture plants, but the work seems to be well in hand, and the methods employed are of a high standard.

Genetics is a comparatively new science. A visitor from overseas realises

this in Australia, where geneticists are very few and far between and where most of them are almost exclusively devoting themselves to practical work. Very few theoretical geneticists are working at the Australian universities. A few men are teaching genetics without being themselves actively engaged in helping to build the foundations of theoretical genetics.

Not all Australian experiment stations engaged in breeding or in the study of breeding methods are of the same high standard. I am not thinking of an occasional breeding station where I could not discover any interest in research or in experimental work at all. But I sometimes received the impression that even in Australia, a young country, there is some danger that the older men, especially when they have to do much teaching, will become very much set in their opinions, unless they are kept in touch with the new developments of science or at least with the results of experimental work. Such men will gradually come to believe that what they have once learned is the eternal truth and they will resent newer facts that tend to shake the foundations of their faith.

B. The Role the Science of Genetics can Play in the Future Development of Australian Agriculture

The genes, in their distribution over the germ cells, are not affected by our knowledge or lack of knowledge concerning those processes. We can only obtain our results as breeders by a suitable choice between the individuals, by a preference of some over the majority. If the method of selection and the foundation material are both suitable, it is not necessary that the man who manipulates the succeeding generations has any knowledge of genetic principles. The handler of animals requires no knowledge of physiology if he feeds his animals correctly and it does not matter whether he does it because his father did the same or because the boss tells him to do it. For a breeder to say that he applies some Mendelism in his work sounds exactly like "applying some gravity" in going downstairs.

It is quite unnecessary to teach genetics to the breeders themselves. The relation between the scientists and the breeders should be of such a nature that the breeders take the scientists' experience and knowledge for granted. This result can be best obtained by pointing out what practical results have already been obtained in the breeding of other material, or by explaining (in the simplest terms) how a well-known method of selection works.

Where we geneticists can help the breeders is in helping them to choose between several methods of selection, in helping them decide whether their standards of quality are reasonable or unreasonable, in showing them errors even where they sound plausible, and in helping them choose the correct foundation stock.

Geneticists must have wide Practical Experience

To be able to help the breeders a man is very ill-equipped when he merely "knows his genetics" as he knows his multiplication tables. To be of any value he must be thoroughly experienced. Real practical experience, of co-operation with actual breeders on actual amelioration of groups of agricultural plants or animals, can only be obtained slowly and gradually. An enormous amount of experience can be gathered from experimental work set up to answer pure theoretical questions.

Genetics is essentially an experimental science. Perhaps in this science, more so than in many others, it is true that theoretical science, like Janus, looks both ways—to the past and to the future. We are continually comparing our firmly fixed older beliefs and subjecting them to the test of new experimental evidence, modifying them where necessary.

Truth in science is relative; it is what is true today, and our present doctrines only appear fixed and immutable to the man who gets his science secondhand, never to the man actively helping to build the edifice of his science. In genetics, the results of recent experimentation are often of the greatest practical use when we are trying to help the breeders to choose their methods well. To give a few instances: Fisher's and my own recent experiments on the nature of dominance have helped me enormously to understand the good points and also the limitations both of individual selection and of selection according to genotype. Our own experimental work with plants and animals on the origin of entirely novel characters, mostly double recessives as the result of crosses between strains of similar appearance but with different chromosomal arrangements, has given me a useful working knowledge applicable where transgressive variability is desirable. A synthesis of widely diverse facts that gives us an insight into the nature of the genes and into gene action proved to be of the greatest value in making it clear to the practical breeders in simple terms why the effects of the environment should be restricted to the individual experiencing them.

I am perfectly convinced Erwin Baur was right when he maintained that a man helping the breeders in their methods should at the same time be actively engaged in purely scientic research.

The Provision of Adequately Equipped Geneticists

Coming to the possibility of obtaining the best genetical guidance for the Australian agriculturists, we must first realise that experienced geneticists are rare. Even if the money required should be available, it would, I fear, be out of the question to find three or four young geneticists with the required grasp of the breeder's problems. I should judge that even the Australian Universities would not sound very attractive to my colleagues in good standing, chiefly for the reason that, just as is the case in France, this country somehow did not happen to produce any first-class work in theoretical genetics, with rare exceptions (Agar).

Training Overseas

One solution will be to send a few younger men to foreign Universities. In that case the permanent success of such a method will depend largely upon the choice of such men, and I repeat that it will be necessary to find men with a natural aptitude for helping to build our science by means of experimental purely scientific work. Otherwise, it would be necessary to repeat this process of teaching the young men overseas indefinitely. I should think the first thing necessary is to establish a focus of genetic research where young men can be trained in the co-operation with breeders and imbued with a respect for the nature of pure science. If this could be done, the young geneticist-pupils could be much more easily recruited and chosen for their ability and their previous grasp of the problems and the difficulties of Australian agriculture. In the course of my tour, I met several young men at the Colleges and in the Agricultural Departments that would be ideally suited for this work.

Consultative Geneticists

This is the place to say something about the work geneticists could be expected to do in Australia. In my travels, I have been repeatedly asked whether I could not find a young geneticist for some experiment station or college or department. My answer has always been that the needs of the department or college under the present circumstances were not of such a nature that they would require a "whole" geneticist. I have been called into many conferences about breeding plans and policies, and I have come to the conclusion that in the majority of cases, it would be ample if a good geneticist were available once a year for just this

kind of consultative work. This would hold good both for the work in experiment stations and for such work as the planning of an artificial insemination centre where this was intended as a nucleus for dairy cattle breeding work, and similar work of this kind.

In the presnt circumstances, there is no reason why I should avoid using my own case as an example. If I happened to be less close to any official retiring age limit, I think I would not only love to act in such a consultative capacity, but I would probably be able to do a great deal of very useful work in Australia. If I be permitted to use myself as an example, I find that, although I have been an experimental geneticist all my life, it took me almost to my fiftieth year fully to co-relate my scientific experience with the ability to help and influence the practical breeders. This, I think, does not mean that I am especially slow and dense; I believe it was mostly due to the necessity of a lot of pioneering in this particular field. A young man specialising in this work could certainly, with some guidance, be expected to get where I am, in, say, half a dozen years.

Establishing a Chair of Genetics at a University

Apart from stop-gap measures to aid Australian agriculture by the aid of genetics (and temporary measures are unavoidable, I am afraid), the ideal solution would certainly be to establish a Chair of Genetics at one or two of the Universities, where the man in charge would have the necessary endowment and equipment to have a number of pupils that could do fundamentally scientific experiments on the solution of purely theoretical questions. Although, in choosing the incumbent, the needs of agriculture should be kept in mind, and it would be inadvisable to stipulate that experimental work should be done with sheep rather than with rats, with wheat rather than with snapdragons. The main object would have to be the establishment of an Australian focus of genetical research. Here the future Australian geneticists for whom there will be such an ample demand should be trained, both in a feeling for the practical problems and in a respect for the nature of scientific truth.

In the meantime, it would help enormously if Australia could find any experimental geneticist capable of acting in a consultative capacity in the planning of projects, or the solution of problems in a somewhat similar way as I tried to do when called upon to do so during my short visit to Australia. It does not seem impossible to me to induce one of my experienced American or Scandanavian or even British colleagues to undertake to come over to Australia for regular short periods during a number of years. Such an arrangement might even result in the discovery of excellent "local talent" in Australia.

My lecturing tour in Australia has been of enormous interest and pleasure to me. I have learnt even more than I taught. It has proved to me once more that it is possible for a geneticist of some experience to make himself understood by practical men, using the simplest language, without dangerous over-simplification.

I have thoroughly enjoyed this experience and I thought it only fair to make my trip as useful to Australian agriculture as I possibly can. This must be taken as the reason for this unsolicited and apparently meddling treatise.

(*Received for publication, September* 14, 1950.)

SOME SOIL FACTORS RELATED TO IRRIGATION PROBLEMS IN NORTHERN VICTORIA

By A. G. GOUDIE

Introduction

In most of the old irrigation settlements in the State, problem areas and undesirable irrigation practices have already been discovered simply by developing convenient areas, adopting convenient practices, and then noting where, and under what conditions, crops die or fail to thrive. The problems are sometimes overcome by suitable reclamation measures or circumvented by substituting alternative tolerant crops. Occasionally, irrigated land has been abandoned altogether because of apparently insuperable difficulties. Each of these courses involves considerable capital loss or expenditure.

The principles of soil physics and chemistry have been elucidated rapidly since the old settlements were established, and it is possible that by their application all serious irrigation problems could be avoided in the areas being developed for irrigation at present. But unfortunately, enormous collections of data would be required to predict accurately what would happen to a particular area when brought under irrigation, and considerable organization would be required to bring all irrigators in even a moderate sized settlement, to a reasonably high standard of efficiency. Trained staff are seldom available for such a programme.

During the present rapid expansion of irrigation in Victoria, it is not possible to completely investigate the physical and chemical properties of the soils or completely implement efficient irrigation practices for the new irrigators. Standard soil surveys have been carried out in the Robinvale and Cobram-Nathalia areas where much of the post-war Victorian expansion is taking place. These surveys collate most of the data available on the chemistry and morphology of the soils. This paper is a discussion of some of the other factors which are known to affect the productivity of soils being brought under irrigation, and which may influence the development of new areas.

The Salt Content and Permeability of Soils

Two fundamental soil factors underlie most irrigation problems, viz., the salt content of the soil in the virgin state, and the permeability of the soil. Most other considerations arise from these two factors. Native salt has been studied in some detail during soil surveys and therefore the subject will not be discussed quantitatively in this paper. The third factor often included in this type of discussion, viz., the intake of salt in irrigation water, requires little immediate thought because, nowadays, most Victorian irrigation water only contains about 5 parts per 100,000 of salt. Toxic salt accumulation could conceivably occur in the root zone after fifteen or twenty years at this rate. But occasional heavy irrigations or untimely rains are sure to occur at intervals to leach such

A. G. GOUDIE, B.Agr.Sc., is an officer of the Victorian Department of Agriculture and is stationed at Tatura. *This article is based on an address he gave to the Melbourne University Agricultural Society on September* 1, 1950.

salt below the root zone. There might ultimately be a limit to this safeguard.

Soil permeability is perhaps the aspect of irrigation which has received least scientific attention. Ideal soil permeability is not a purely theoretical possibility. Such soils do occur over quite larger areas especially in the Goulburn Valley region. It will be seen from Figure 1 that such soils can have water run on them for anything between 5 and 12 hours and still the amount of water is near enough to the requirements of most plants. We are interested mainly in the gross deviations either side of the ideal.

The occurrence of irrigation problems is best discussed in two separate regions, with the boundary near Echuca. To the West, the soils are mainly Mallee types. They are characteristically of high permeability and high native salt content. In the second region, to the east of Echuca, the soils are mainly red-brown earths. Their permeability tends to vary about the ideal, while native salt is in general negligible.

DISTRICTS WEST OF ECHUCA

Soil Permeability

The high permeability in these soils is illustrated by records of water used. Records are available for Red Cliffs district, an 11,000 acre settlement, and show that an average of nearly 3 acre feet per acre are used annually, while in dry years, the average annual usage approaches 4 feet[1]. Records from the few blocks fitted with meters show that individual blocks may use over 7 acre feet of water per acre in a dry year[2]. Transpiration and evaporation will seldom account for much more than 2 feet per annum of this water. The rest is lost to drainage and deep percolation. Of course,

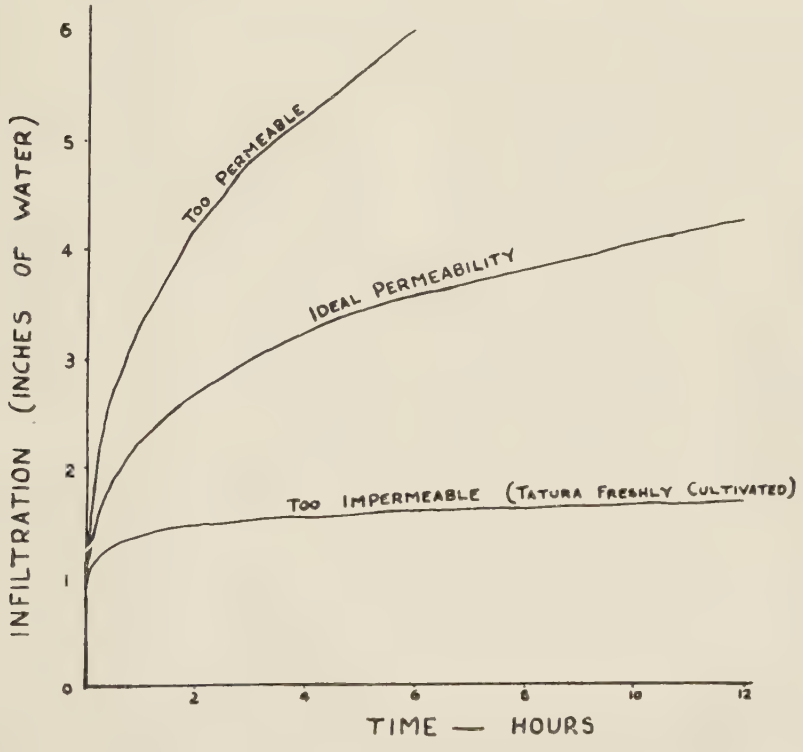

Figure 1
Typical Infiltration Rates

these soils are not of uniformly high permeability. The soil properties, texture and structure cause quite large variations. For instance, Winkie Sand has a minimum infiltration capacity of about 20 in. per hour compared with Moorook Sandy Loam about 3 in. per hour[5], the difference being primarily due to texture. Among the heavier Mallee soils, exchangeable sodium may have a big effect on permeability. For example, quite large areas of Tatchera Sandy Loam at Tresco contain up to 40 per cent. of their exchangeable cations as sodium. The subsoil is so impermeable that reclamation by drainage is hopelessly slow[4].

A high soil permeability is not an undesirable feature—in fact, crops such as citrus and many vegetables grow best on this class of soil. The trouble is that high permeability usually leads to overwatering and its undesirable results, simply because the average irrigator is not trained, nor is his layout or equipment designed to apply less than 4 in. per irrigation. The principles on which correct practice must be based, are well known but they are not often sought nor fully accepted by all those involved in developing new areas of permeable soil. For instance, the basis of efficient furrow irrigation is the slight grade design which permits the use of high flow rates in the furrows. The principles of this design were enunciated by Pennefather[3] twelve years ago, yet it is rare to see ideal slight grade plantings and watering methods on our newly developed Mallee soils. Also, despite the obvious desirability of irrigators knowing their water usage, meters are not installed on the majority of blocks. In an undrained area, it is only a question of time before over irrigation leads to a high water table and possible salting.

Drainage

The economic success of drainage is mainly dependent on the subsoil being quite permeable. It costs nearly £100 per acre to instal a system with tile drains 6 ft. deep and $1\frac{1}{2}$ chains apart, so that drains really cannot be laid much closer than this. Therefore, the subsoil must be permeable enough for water to move $\frac{3}{4}$ chain laterally, with only a 3 ft. head.

Many people still think of tile drains as putting a low outlet into an underground lake. Tisdall's data[6] on the fall of water tables in relation to depth and spacing of tile drains refute this conception and give a good practical example of the quite intense resistance presented by normal soil to the lateral movement of ground water. Figure 2 shows how even in a light soil, the surface of the water table never levels right out, and flow has just about stopped after three weeks with the hydraulic gradient at about 2 ft. per chain. It is disturbing to see how some orchardists on the few rare permeable soils of the Goulburn Valley pin their faith in a single 6 ft. deep open drain when in fact, such a drain would not be effective outside a radius of 2 chains at the most.

Some areas, such as Woorinen, near Swan Hill, are unfortunate in that their soil is usually permeable enough to be over-watered, and a water table built up, yet not quite permeable enough for drainage to be economic. The final hydraulic gradient is something like the 3 day water table gradient for Barmera Sand, i.e., drains are only effective for the adjacent rows. Nevertheless, many growers still instal drains in unresponsive soil types.

Problems of low permeability of surface soil may occasionally arise in Mallee soils. For instance, some time ago, Mildura growers requested that a trial be laid down to determine the effect of annual dressings of packing shed waste on the organic content of soils of citrus orchards. Packing shed waste consists of grape stems and pedicels, together with a proportion of damaged berries, the whole containing about 10 per cent. sugar. It was applied in early Spring,

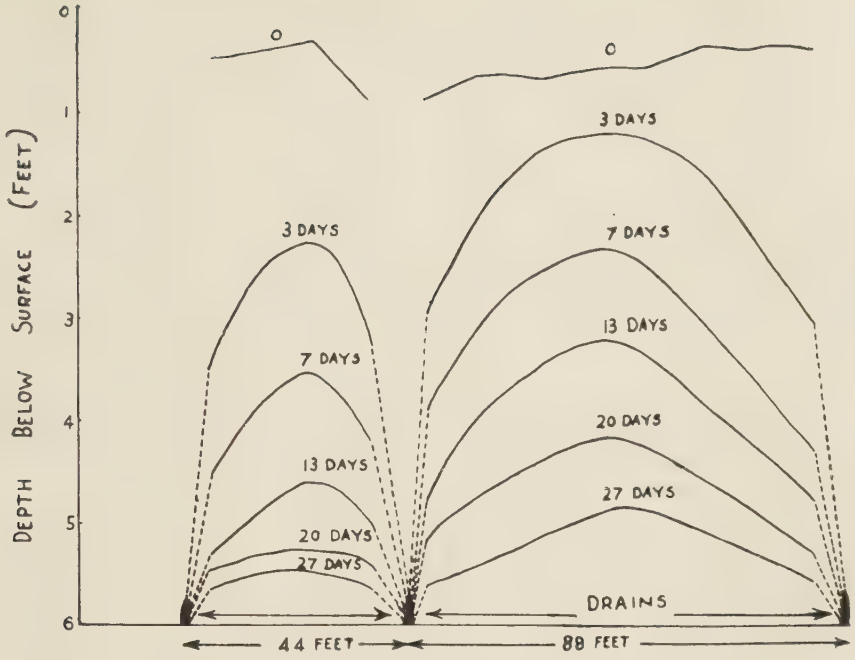

Figure 2

Fall of Water Table into Drain—Barmera Sand (from Tisdall[6])

at about 10 ton per acre in a randomised trial on a citrus grove on moderately heavy soil. By December the shed waste plots were heavily defoliated and examination showed that irrigation water was only penetrating to a depth of a little over 15 in. Apparently, bacterial decomposition of the sugars resulted in the production of polysaccharide gums which clogged the soil pores. Within a few weeks, presumably when the polysaccharides themselves were decomposed, the soil had returned to its normal permeability. However, the current season's orange crop suffered a permanent setback.

DISTRICTS EAST OF ECHUCA

Soil Permealibity and Drainage

Salt is no problem in the Goulburn Valley Region, except for a few minor areas mainly around Rochester. Therefore, the only soil factors of importance to irrigation are those related to permeability. Much of the area is of ideal permeability, and many orchards and pastures have been irrigated for years simply by changing over the irrigation sets morning and evening. Even so, high water tables are infrequent and compared with the irrigated areas West of Echuca, the problem of excess permeability is of limited importance.

This statement may be challenged by those who realise that the main channels in the Region are normally unlined and that they are cut right down into the "C" horizon which is normally quite permeable. In fact, the native water table in the Cobram area has been rising at the rate of 1 to 2 ft. a year, and will eventually rise to the channel beds in a number of places, as it has in the older Goulburn Valley settlements. Silt from the percolating channel water eventually clogs up the soil pores and may completely stop percolation. But even apart from this limitation, the channels cannot build up an underground lake that will waterlog a wide expanse. Water moving

through normal soil requires a hydraulic head of something like 2 feet per chain and this applies not only to water moving out of soil into drains, but to water moving into soil from channels. Thus, while unlined channels may reduce the margin between over-irrigation and waterlogging, widespread high water tables depend finally on excess water being applied by surface methods. The soils of the Region are themselves, a good safeguard against this because of their usual ideal or low permeability.

The Effect of Cultivation on Permeability

Impermeable soils appear to be fairly widespread among the cultivated sections of the Region. Apparently the effect is usually caused by cultivation, though odd cases of mild impermeability have been noted in virgin soils. The effect of cultivation is probably twofold. Firstly, the soil aggregates are not particularly stable in the major types and these are largely destroyed by the pulverising action of implements. The pulverised remains of the soil crumbs are so fine that they pack together and restrict the pore space through which water normally passes. Secondly, the passage of implements over the ground is thought to push the surface loam into the pores of the underlying clay, usually only 6 or 8 in. below the surface. This effect is probably important only when the soil is quite moist. The net result may become very serious. For instance, the Tatura Research Station soil became so impermeable after less than ten years' horticulture that water would only penetrate to a depth of 8 or 10 in. even though it was held on the surface for as long as a week. The effect may well have been aggravated by early efforts to keep the orchard scrupulously clean, in order to set an example in orchard hygiene to growers. Special measures have now to be taken to maintain productivity. These include flood irrigation of the trees at frequent intervals, determined by the summation of daily black-pan evaporimeter readings. In hot weather, the interval may be as short as a week. Such measures are not available to growers who are on a strict roster system, and in such cases, impermeability is a particularly severe irrigation problem.

Existing Goulburn Valley orchards, especially in the Kyabram-Tatura area, often have fair sized patches of stunted trees scattered through them where the soil is impermeable. Under peaches, the economic loss is quite heavy, because not only is the total yield low, but a large proportion of the fruit has to be rejected as undersize. On the other hand, canneries accept all apricots, irrespective of size, while pears grow quite large even on impermeable soil.

Soil Surveys

The new Soldier Settlement in the Cobram-Nathalia area contains soil types similar to those in the older settlements of the Goulburn Valley Region. Therefore, as many as possible of the proposed fruit blocks are being surveyed in detail, in order to try to define broadly, the different levels of permeability. Where possible, very impermeable blocks are re-allocatd to pasture. Otherwise, the least permeable section of a fruit block remains unplanted—and there are always at least 10 acres of spare ground on the fruit blocks, the moderately impermeable areas are planted to pears, plums or apricots and the permeable areas are planted to peaches. Early and midseason peaches are planted on the best soil on the block because they are the most difficult fruit to bring up to canning size.

In areas of Mallee soils, standard soil surveys do appear to indicate with reasonable accuracy from a consideration of texture alone, the large differences in permeability that do exist. But in the Goulburn Valley Region, the effect of texture on permeability may be completely masked by difference in soil structure. Thus, a standard soil survey may be used with confidence to choose an area broadly suitable for horticulture, but it is unwise

to attempt detailed planning of an individual block from a consideration of soil types alone. At present, no standard method is available for surveying large areas to estimate the permeability of such soils, although quite satisfactory laboratory methods have been evolved for determining, on individual horizons, such relevant factors as porosity, apparent density, permeability under saturated conditions, and water stable aggregates.

Infiltration Surveys

The Soil Probe Method

Penetration surveys give a good field indication of permeability. The area is given a standard irrigation and then the depth of water penetration is determined by means of a soil probe. From experience in the older settlements, a reasonable, though arbitrary, basis of classification is that areas with a penetration of over 2 ft. 6 in. are permeable, those with less than 15 in. are impermeable, and the remainder are intermediate. This method is not available in undeveloped areas proposed for orchards; neither do laboratory methods appear to be adaptable to broad acre surveys of new areas.

The Infiltration Ring Method

The infiltration ring method, developed by Pennefather[3] was chosen for detailed studies of proposed fruit blocks in the Cobram-Nathalia area. Fundamentally, the method consists of keeping water at a constant level on a confined area of soil, and frequently measuring the amount of water that has soaked in. On these soils, the amount soaking in, plotted against time on log-log graph paper, gives a straight line. This allows fairly accurate prediction of infiltration, from data obtained in little over an hour. The field routine has been developed so as to carry out 25 to 30 determinations per day, using a three-man team. Each "set" consists of five units laid out on a 3-chain grid, i.e., approximately one determination per acre. Readings are taken every ten minutes. The final set for the day is normally allowed to continue, and readings are taken during the evening in order to check and develop the accuracy of prediction.

Results are expressed as a single figure, viz., the corrected five hour value, which is the inches of water expected to soak in during a normal five hour period of multi-furrow or flood irrigation. The graph from readings in the first hour or so, is extended to give a predicted value for the five hour period as is shown in Figure 3. This value is normally within one inch of actual value, and if different, is almost invariably lower. The predicted value is corrected for lateral spread below the infiltration ring, using soil moisture before and after wetting and depth of penetration, as the basis of correction. The final figure is not precise, but variations in soil permeability are so large that broad distinctions are possible.

The corrected five hour values are plotted in position on the block plan, and areas of similar permeability are marked out. The following arbitrary divisions are usually made for variety plantings:— greater than 4 in., early or midseason peaches; 3-4, in. late peaches; 2-3 in., apricots, pears or plums, while a corrected five hour value of less than 2 in. is considered to be too impermeable for horticultural crops. Some patches of soil, suitable from a permeability point of view for peaches and apricots, have poor surface drainage and are planted with varieties less susceptible to waterlogging. Also, trees are not planted on soil types likely to contain a heavily cemented layer in the profile, because of the danger of perched water tables.

Limitations of Infiltration Surveys

An infiltration survey is not a precise mapping of a fundamental soil property. It cannot be precise because soil may vary measurably within an area of a few square yards. Nor is the infiltration rate of a soil a fundamental soil property. Infil-

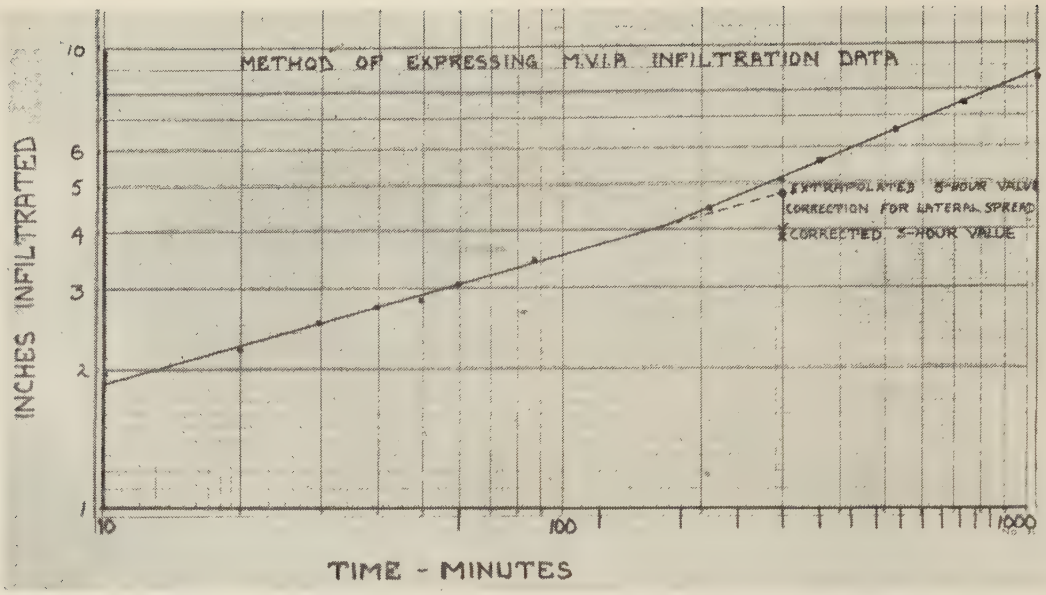

Figure 3

Method of Expressing Murray Valley Irrigation Area Infiltration Data

tration rates vary according to the season of the year, soil moisture, cultivation and cropping history. They may be altered by the addition of sugar to the soil, as mentioned earlier. Claims made concerning the benefits of subsoiling and gypsum applications to "tight' soil presuppose an increase in the infiltration rate of such soils. The composition of the irrigation water and its method of application may also have quite a large effect. Soil and water temperatures may be relevant.

During an infiltration survey, as many as possible of these variables are defined and kept constant. Determinations are carried out only in the summer and autumn because comparable soils at Tatura have by then reached a steady infiltration rate after the relatively high spring rates. Survey work is suspended after rain, until the soil dries out. Soil in the test area is freshly cultivated to a depth of 3 in. and since there are few readily accessible sources of water in such undeveloped districts, the same quality of water is used over quite large areas.

The Effect of Cropping on Infiltration

Past cropping history cannot be controlled and is usually difficult to define. The only distinction attempted is that between soils that are either virgin or cultivated, cultivation in this area consisting of a system of cereal growing under dry farming conditions. Infiltration rates are almost invariably much higher on virgin soil than on adjacent crop land and the order of difference shown in Figure 4 is typical. Horticulture is almost certain to lower present infiltration rates, and in fact, infiltration rates in, say, ten years' time, may well be a reflection of the type of orchard culture rather than of initial rates.

Discussion on Infiltration at Recent Conference

Infiltration determinations were discussed at the Technical Conference on Irrigation held at Griffith in September, 1950, subsequent to the reading of this paper. From the point of view of the soil physicist, infiltration was considered

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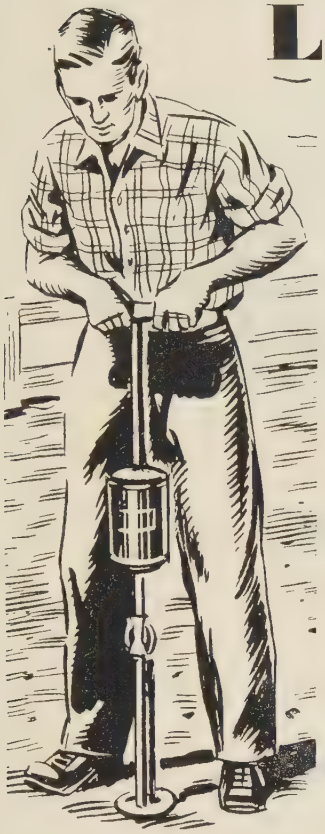

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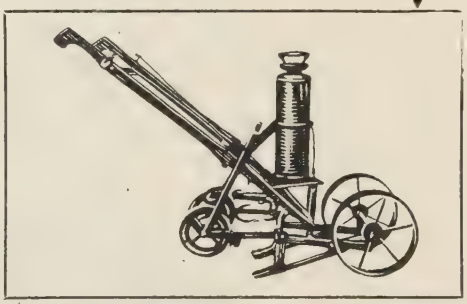

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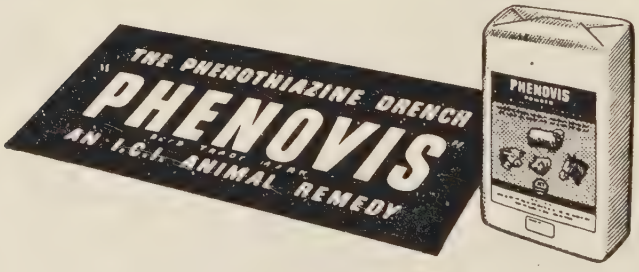

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to be an unsatisfactory measure because it is controlled by too many variables to permit really accurate studies; also infiltration determinations do not provide any fundamental data suitable for the detailed study of the process of infiltration, or for a study of the fundamental changes that might occur under different cultural treatments. For instance, a differential decline in infiltration rates on two horticultural blocks initially the same, might be due to a difference in initial structure stability rather than to subsequent cultural treatments.

On the other hand, it was agreed at the Conference that infiltration measurement was of more direct application to immediate irrigation practice than were the fundamental physical determinations, which are carried out on individual horizons. But the effect of controlling variables, already discussed, must be borne in mind.

Infiltration Survey in Cobram-Nathalia Area

The infiltration survey in the Cobram-Nathalia area was initiated because the vigour and productivity of mature trees in the Region varied considerably within soil types. Low infiltration rates were associated with poor trees. Similar variations in infiltration rates were found to occur on the undeveloped areas, and no other practicable method appeared to be available to predict broadly the probable irrigation behaviour of a particular area. Figure 4 illustrates an extreme example. The whole block is mapped as Cobram Loam and yet considerable areas are already too impermeable for successful peach culture under existing irrigation rosters, while other areas require special irrigation treatment to avoid waterlogging. The area of extremely high permeability may be wrongly typed. But the remainder of the block contains variations typical of those found within the one soil type on other blocks. On a comparative basis, it is obvious from the infiltration data that, except for a small tongue of a different soil type, peach growing is less likely to be successful on the old cropped soil than on the virgin soil. On a quantitative basis, it is obviously going to be difficult or impossible to apply

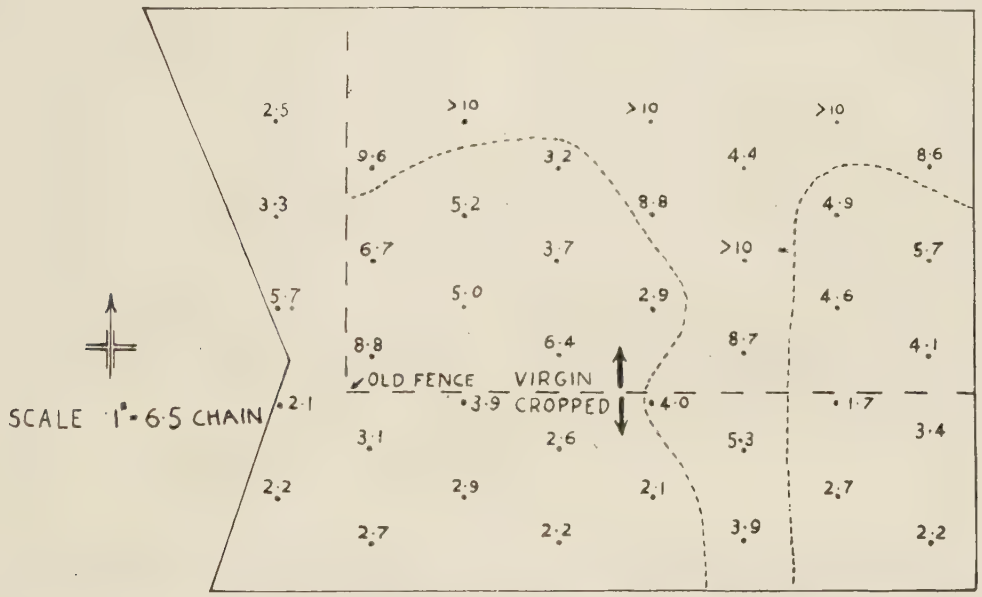

Figure 4

Inches of Water expected to Soak In during 5-hour Waterings—Block 10

the desirable 4 in. of water per irrigation to much of the cropped area.

It will ultimately be possible to test both the comparative and quantitative accuracy of this survey because Dethridge wheels are to be fitted to the blocks, and comparative tree growth is easy to assess simply by measuring butt circumference. About 600 acres, comprising about one quarter of the proposed area has been surveyed so far. Total costs amount to approximately one pound per acre. However, it is possible and desirable to develop detailed soil structure descriptions, thus permitting intense and accurate subtyping of proposed orchard soils by inspection methods alone.

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INSTITUTE OF AGRICULTURE, NEDLANDS, WESTERN AUSTRALIA

REPORT FOR THE PERIOD 1938-1948 BY THE DIRECTOR, PROFESSOR E. J. UNDERWOOD

(University of Western Australia, 1949, pp. 69.)

The report has been published in order that people may become aware of the part this relatively new organization is playing in the field of Agricultural Science. Professor Underwood tells of the establishment of the Institute, its financial position and internal organization.

The Institute carries out the teaching of undergraduates in the four year course for the degree —Bachelor of Science (Agriculture). Finance for this purpose is made available from normal University funds. Another important function is that of research which is carried out in cooperation with the State Department of Agriculture and the Commonwealth Scientific and Industrial Research Organization. Emphasis has been placed as far as possible on the direction of recent graduates in original work for higher degrees. Until recently finance for research has been largely by short term grants from interested organisations. A recent endowment and several newly established research funds have made the position more secure.

A brief review of the more important research projects carried out in the past ten years follows. It shows the broad front on which workers of the Institute are attacking the varied Agricultural problems of the state. A great deal of their work has been directed towards pastoral problems and biological research on sheep. Other aspects of Agriculture have not been neglected and economic studies of various aspects of the more important farming industries of the State have been completed. Work has also started on the chemical composition of wheat and its mill products. The Institute accommodates senior officers of the Commonwealth Scientific and Industrial Research Organization and their presence provides a stimulus to the work proceeding there.

Although much of its work has been published independently, this is a brief and interesting summary of the activities of a young but flourishing Institute.

K. H. HAYES.

AGRICULTURAL EDUCATION IN GERMANY

By F. SKALLER

The application of agricultural research through education is a most powerful tool for raising the productivity and efficiency of primary production. However, the task of disseminating knowledge amongst primary producers, especially in countries where the majority of farmers are peasants as in Europe and Asia, is made difficult by the enormous number of small producers and the wide range of activities and skill required for the mixed type of farming which predominates in these countries.

Farming in Australia differs in some degree from these characteristics of European farming, partly on account of the climatic conditions and distances from major markets, and partly because Australia is, relatively, a recently settled country where farming is based on free enterprise. Hence the difference in outlook between the "farmer" in the new countries and the "peasant" in the old. Whereas in Australia we have comparatively large units of production and rather specialised farming, we find mixed farming on smaller units in Europe.

It is obvious that agricultural education must be adapted to meet these different forms of primary production. The system of education described in this paper was rather efficient in Germany and, no doubt, some of the features described could be incorporated in the Australian system, especially in districts suitable for closer settlement.

Agricultural Education at the University level

Prerequisites for a Degree in Agricultural Science

Enrolment for agricultural degree courses at Universities or Institutions of similar academic standing is open to male and female students who comply with the two following basic conditions:—

i) They must have successfully completed the 12-year course of a Secondary School and passed Matriculation (Abitur). Their average age is then eighteen years.

ii) They must have been apprenticed for two consecutive years at an accredited training farm, and at the end of this period, have passed a practical examination before a Commission consisting of farmers and one officer appointed by the Department of Agriculture. Only farmers of high professional reputation have their farms accredited. The farms must not be too specialised and usually no more than two students are apprenticed on any one farm.

The agricultural student is therefore at least twenty years old when admitted to the University and already has some practical knowledge of farming.

Apart from the fourteen Prussian Universities, nearly all of them with Schools of Agriculture, there existed in the State of Prussia two large Academies for the study of agriculture (Landwirtschaftliche Hochschulen). The most famous one, which is in Berlin, was founed by Albrecht Thaer as early as 1806. These Academies had the status of Universities, but were under the supervision of the Minister of Agriculture instead of the Minister for Education. They had more students than the Agricultural Schools of the Universities; for example, during the period 1920-25 more than 1,000 students were enrolled annually at the Agriculture Academy of Berlin. This Academy had at least twelve Chairs with Professors who were at the same time

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heads of research laboratories. Veterinary Science was taught in similar Academies for Veterinary Science, the most famous one being in Hanover.

Syllabus for the Degree Course

The syllabus for the degree course in agricultural science was prescribed by the Minister and was therefore uniform within the State for all Institutions which had the right to confer this degree. This not only guaranteed a minimum standard of knowledge, but also permitted students to attend different years of their course at different Universities. Most Universities had at least one Professor who was a well known authority in some special field and therefore attracted a large number of students.

The length of the ordinary degree course was three years, equivalent to six semesters, as the academic year was customarily divided into two semesters. The first three semesters were devoted to the study of Zoology, Botany, Chemistry, Physics, Geology and Mineralogy, Introduction to Genetics, and Animal Physiology. The second three semesters dealt with the more specialised subjects of agriculture. Major subjects were Plant Production, Animal Production, and Farm Management and Valuation. In addition, the following minor subjects had to be done—Soils and Plant Nutrition, Animal Nutrition, Agricultural Engineering, Agricultural Law and Economics. Examinations were held in all these subjects. In addition, students could attend lectures in specialised subjects such as Marketing of Agricultural Products, Poultry Farming and Wool Classing.

Some examinations were oral, the others consisted of writing essays both as homework and under examination conditions. Marks were given ranging from "Very Good" to "Good", "Passed" and "Not Passed". One failure in a minor subject could be compensated by a good mark in another subject, but in all major subjects a student had to obtain at least a pass mark. When students failed in one or two subjects, they could sit for the examination one year later, but only once.

After the successful completion of this three year course the degree of B.Agr. Sc. (Diplomlandwirt) was conferred. Post graduate work consisted usually of doing research at one of the many specialised Institutes and was often concluded with the presentation of a thesis for the degree of Dr. Agr. Sc. (conferred by the Agricultural Academies) or Dr. Phil. (conferred by the Agricultural Schools attached to Universities.)

Special post-graduate courses

Livestock Science Officers.—Graduates entering this course had to have at least one year of post-graduate experience in animal husbandry and breeding work at a recognised Institution, and one additional semester in Animal Science at a University or Academy.

Examinations had to be passed in the following subjects: Livestock and their relation to Farm Management, Animal Husbandry, Animal Breeding, Judging of Livestock, Animal Nutrition, Cultivation of Fodder Plants, Management of Pastures and Meadows, Private and State Measures for the Improvement of Livestock, Hygiene, Obstetrics and Disease Control. Students were examined before a Board of University Professors appointed each year from different Universities by the Minister for Agriculture.

Only those who had passed these examinations could be employed as Livestock Officers by the State and semi-State organisations.

Plant Breeders.—A similar course was held for students wishing to specialise in this branch of agriculture.

In comparison with Australian standards less stress was laid on Bio-chemistry, but more on Animal Science. In addition, Farm Management was taught as a major subject. It included the co-ordination of

the specialised branches of agriculture to allow the efficient organisation of a farm, to choose the type of farming suited to particular environments as affected by climatic conditions, soil types, distances from the markets, labour costs, available capital and rate of interest, and the skill of the farmer. The efficient management of labour, the valuation of farms, accounting and cost surveying, crop rotations and their influence on farm organisation, were all included in this important subject.

The degree course was not designed to produce highly skilled specialists who were trained by post-graduate work for specialist careers. The majority of graduates found employment as teachers at the Agricultural Winter Schools, as officers of Agricultural Departments with their widespread Extension Service, as administrators of large estates, as farm valuers, and as officers of all types of organisations connected with primary industry. In the early thirties there were more than 10,000 agricultural graduates in Germany, exercising substantial influence on all phases of primary production and agrarian policy.

Agricultural Education at the College level

For those who wanted a shorter course where more stress was laid on the needs of the practical farmer, and for those who did not have the school qualifications required by the University, a few Agricultural Colleges had been established. Their courses extended over two years and were of the type provided in Australia at the Agricultural Colleges at Roseworthy, Dookie or Hawkesbury. These courses were mainly attended by the sons of the owners of middle-sized farms. Sons of the large estate-owners (Junkers) often attended the Universities, while sons of the peasant farmers were usually sent to the Agricultural Winter Schools described in the following section.

Agricultural Education for the small Land-holder

The basis of the agricultural education system was provided by the Agricultural Winter Schools, so called because courses were given only during the Winter when the amount of work on the farm was reduced and the assistance of some members of the farmer's family was not required. The majority of the peasants' sons, who had not left the farm for other occupations, attended these classes. A full course consisted of two Winter semesters. The subjects taught were Farm Management, Animal Husbandry, Soils and Crops, Pasture management, Farm Machinery, and Farm Accounting. Pupils were at least of minimum school leaving age, and were usually between sixteen and eighteen years of age. Some schools had also special courses for girls in domestic science, poultry and dairying. The staff of each school consisted of a headmaster and one to three teachers, all graduates in agriculture with one year of post graduate training in Education.

Nearly every county ("Kries") had such a school. A Kries was the lowest administrative unit into which the State was divided. For instance, the State of Prussia, which was the largest member of the federated German Reich, was divided into twelve Provinces, each of them with about fifteen to twenty-five Kreise. Prussia, which was approximately 25 per cent. larger than Victoria, with a population of nearly 39 million inhabitants had approximately 250 Kreise, nearly all of them with Agricultural Winter Schools. Taking into consideration the different densities in population, a better picture for comparison might be provided by saying that all Australian country towns with a High School would also have an Agricultural Winter School.

Agricultural Extension Services

The Importance of the Winter Schools

The Agricultural Winter School with its staff of trained technicians constituted

also the backbone of the Agricultural Extension Service. During the winter months most of the staff's time was taken up with teaching, but during the remaining half year it would devote its time and energy to extension work. The school provided an ideal basis for this service as it made the extension worker's approach easier because many of the farmers approached were the parents of pupils or often former pupils. The headmaster thus became much more than the director of a school, and his influence and social standing within the community were such that he was often called the "uncrowned king of the county."

The Agricultural Winter School was controlled by the Provincial Department of Agriculture. The headmaster and teachers, were officers of this Department and from the school a stream of information and statistical data flowed to the Department's Head Office. In turn instructions and technical information were issued from the Divisions of the Department to the headmaster and his staff.

Other Agencies for Extension Work

Extension work was also carried out by a diversity of agencies, many of them organised and controlled by the Agricultural Winter School, or nearly always run in close collaboration with it. There were short courses in special subjects, Field Days at selected farms, Competitions, Young Farmers Clubs, Cow Testing, Pig Testing, and Animal Breeding Associations. There were the numerous Agricultural Co-operatives for the purchase of machinery, fertilisers and seeds, for the collection, grading, standardisation and sale of agricultural products, all of them trying to educate the farmer in more efficient methods of production. Of great importance were the local Agricultural Clubs which organised monthly meetings during the winter season, when farmers were addressed by experts, mainly provided by the Provincial Department of Agriculture.

Specialist Departmental Officers—The close collaboration between Winter Schools and the Department's specialists is illustrated by the following example:—

The Livestock Officer in charge of Poultry would organise perhaps twenty to thirty Poultry Field Days and one-day courses, each in a different district. The spade work for such organisation would be done by the staff of the Winter Schools. The specialist Livestock Officer would plan the syllabus of the course, give some lectures himself and invite other officers or prominent farmers to talk on other subjects.

There were numerous systems of accreditation for breeding farms, seed certification, etc. This work was usually carried out by a Commission consisting of a specialist Departmental Officer from Headquarters, the director of a Winter school and a practical farmer. The director of the Winter school would organise the itinerary, act as a liaison officer, provide a lot of confidential information from his knowledge of the district but leave the responsibility of decisions to the specialist Officer. This assisted in maintaining a uniform level of accreditation for the whole province, and removed the onus of sometimes unpopular decisions from the local resident Officer who had to remain in friendly and permanent contact with all farmers.

In districts with a sufficient number of larger estates six or more of them would form their own research group and employ an agricultural graduate. He would advise them, test their soils, lay out manure and seed trials, work out feed rations, suggest crop rotations, supervise breeding work, carry out time studies to raise the efficiency of labour, and make cost surveys and other statistical studies concerning the efficiency of the individual farm organisations.

Livestock Breeding Associations usually had agricultural graduates as their chief officers. In addition, the Provincial Departments of Agriculture employed a number of Livestock Science Officers who

resided in country centres. They were usually in charge of the promotion of the livestock industry in a number of counties and carried out a policy directed by the Chief of the Livestock Division. This Division had subdivisions for all classes of Livestock all headed by graduates with qualifications as Livestock Science Officers.

Financing Extension Work.—The Provincial Departments of Agriculture were Public Corporations with a large staff of professional officers, presided over by a chairman and a council consisting of farmers elected by all farmers of a Province. This Corporation had the right to impose levies on farmers to raise the necessary funds for paying its staff and other expenses. These levies were collected by the State with all other taxes. Additional funds, however, were provided by the State through the Ministry of Agriculture from funds allocated by State Parliament. Thus State assistance was closely integrated with farmers' self-help. Farmers talked of "their Department of Agriculture", yet the State had great influence by granting funds, often with certain conditions attached to them. For example the State paid 50 per cent. of the salaries of the Livestock Science Officers, provided they had passed the necessary examinations.

All extension work was supplemented by the distribution of free leaflets and bulletins, and the issue of a Farmers' Gazette which was written in simple language to appeal to the small land-holders.

The Training of Agricultural Labour

Not only the farmers themselves were trained, but also many of their skilled workers and assistants. Special schools existed for the training of milkers. Field officers who had attended at least a Winter School or often an Agricultural College were employed to assist in managing large farms. The career of Poultry Assistant was chosen by many young girls and boys. After two years apprenticeship at an accredited Poultry Farm they passed a Poultry Assistants' examination. They could then attend a course of one year at one of the many State Poultry Training and Experimental Farms and graduate with a Diploma. Similar schools and courses existed for personnel engaged in pig husbandry.

The Organisation of Agricultural Graduates

Agricultural graduates had a professional organisation similar to the Australian Institute of Agricultural Science. This association tried to improve the financial position of the agricultural profession, to raise its social status, and to open up new fields of employment. The latter was very important, as more graduates were available than jobs. Many positions, which had been filled before the First World War by Veterinary Officers, were now filled by agricultural graduates with qualifications as Livestock Science Officers. Agricultural graduates also replaced the legally trained administrator in nearly all fields of the State Agricultural Administration. Banks employed more and more graduates as experts to value farms and farmers' co-operatives or to advise farmers who became insolvent. Taxation Offices employed agricultural graduates as valuers.

The Institute obtained reduced Premiums by entering into agreements with Insurance Companies, Sick Benefit Societies, etc. It also gave legal assistance, and negotiated salary scales and conditions of employment.

The Institute was organized in geographical districts, usually Provinces and smaller units. It was also divided according to employment or training. There were divisions for Agricultural Administrative Officers, Practical Farmers, University Teachers, Agricultural School Teachers, Livestock Science Officers, Plantbreeders and Plant Production Officers. These divisions held annual meetings, whereas Provincial and local group meetings were held monthly.

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ECONOMIC ASPECTS OF AGRICULTURAL STABILISATION SCHEMES

By K. O. CAMPBELL

The four principal features of Australian agricultural stabilisation schemes are:

(1) a system of compulsory saving whereby farmers are taxed and the taxes are accumulated as stabilisation funds which, however, are to be returned to farmers as bounties if export prices fall below the guaranteed price;

(2) an advance guarantee of a government subsidy if and when the stabilisation funds are exhausted;

(3) the fixation of a home consumption price equal to the guaranteed price; and

(4) a guaranteed price which is subject to annual adjustment in accordance with an index of production costs.

A fifth aspect of stabilisation policy, the attempt to "stabilise" the export market by bilateral contracts and multilateral commodity agreements, should perhaps be added. However, the present discussion will be restricted to the domestic phases of stabilisation policy. The economic basis and consequences of each of the above four attributes will be examined in turn. Major reference will be made to the wheat stabilisation scheme, because the stabilisation concept has probably reached its fullest development in that case.

1. WHY ACCUMULATE STABILISATION FUNDS?

Stripped of all its complex administrative details, the stabilisation scheme is primarily a system for enforcing compulsory saving by farmers. This is done in the case of wheat by means of a tax during the period that overseas prices exceed the guaranteed price. In the case of butter, the entire margin by which overseas prices exceed the guaranteed price is pre-empted. The money so collected is held in a trust fund by the Commonwealth Government. These funds will be used to maintain prices to the farmer at the level of the guaranteed price, if and when overseas prices fall below the level of the guarantee.

The effect of this system of forced savings is to re-distribute farmers' incomes over time—to force the individual wheat farmer to save when prices are high and to make his savings available to him when prices are low. The precise operation of the scheme in this manner for each individual is vitiated in practice because of production variability and the administrative necessity of using the pooling principle. These latter matters do not affect the point at issue, namely, the justification for preventing a farmer from saving and spending his income over time in a manner satisfactory to his own circumstances. Four major arguments might be advanced for governmental restriction of individual freedom in this area.

A Contribution Towards Economic Stability

First, there is the argument of those who favour price stabilisation schemes as one means by which the Government might try to stabilise the national economy. Australia has been deluged with

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full employment plans and theories in varying degrees of sophistication since 1942. Stabilisation schemes for primary industries have found a place in most of them.

The argument for this form of governmental intervention is based principally upon the social costs and misery that rise from unemployment in time of depression. Accordingly, measures to maintain a high and stable level of employment are worthwhile, even if labour is maintained at government expense and involves inefficiency in the use of other resources. There are some who would argue, further, that only under conditions of reasonable economic stability is efficient use of the resources of an economy possible.

Offsetting any gains in this direction, there are important stagnation costs involved in stabilisation schemes. Stabilisation reduces the benefits which flow from cyclical variation in economic activity. Such variations contribute to economic progress through fostering innovations and cheaper ways of doing things. There is evidence that advances in agricultural technique are principally achieved in accordance with such a pattern of behaviour. This point has particular relevance for an economy such as our own, where rapid development is so important. Under conditions of stable income, the incentive to expand output, improve production and expand the use of resources is not as great as under the stimulus of anticipated profits.

Australian stabilisation schemes in practice, cannot be regarded primarily as anti-inflationary or income-stabilising measures. Any potential effects the wheat stabilisation scheme might have in this direction have been seriously limited because:

(1) the maximum tax rate is 50 per cent. of the export differential;
(2) the maximum tax is 2/2d. per bushel; and
(3) the Government has agreed that the size of the stabilisation fund shall be limited to a "reasonable amount."

The Government is therefore powerless to lower high income peaks by any substantial amount. The refusal of the farm organisations to allow any sizeable sum to accumulate in the stabilisation fund has led to the introduction of the so-called "revolving-fund principle." This is the principle of refunding tax collections from earlier pools when the stabilisation fund exceeds "a reasonable amount" (originally stated to be £25 million). In years when refunds are distributed, the net intake into the fund may be zero or perhaps negative, even though wheat prices may be high.

The limited size of the tax and the stabilisation fund accumulated must have an almost imperceptible effect in maintaining economic stability. Economists who have advocated stabilisation schemes as countercyclical measures recognise this fact, but usually blame the economic ignorance of farmers for this state of affairs.[4] The fact that more drastic and theoretically more effective schemes are politically impracticable might just as well be recognised.

Stabilisation Funds as an Alternative to Exchange Rate Appreciation

In the last few years the Australian economy has been experiencing strong inflationary pressure from abroad because of the buoyant export prices received for some agricultural commodities. The most obvious economic weapon to meet such a situation is an appreciation of the currency. Chiefly because of the political dynamite inherent in any such move, and also because of the lack of certainty as to its ultimate effects, no action in this direction has yet been taken. In its absence, the efficacy of accumulation of stabilisation funds as an alternative to exchange rate appreciation has been advocated. This argument has reached its most explicit form this year in connection with the wool levy and export

tax which would have an analogous economic effect.

Stabilisation funds have the advantage of being more flexible and more subject to domestic control under present international arrangements than is a fluctuating exchange rate. Such funds, however, are not as pervasive as exchange-rate variation in eliminating the effects of a disequilibrium in the balance of payments. Furthermore, the funds would have to be supplemented by the accumulation of international currency reserves for later use together with appropriate central bank action. To be effective in combating inflation the funds must be frozen and not used as a basis for governmental expenditure. Stabilisation schemes and currency appreciation have similar effects in reducing the incomes of export producers.

But where only a few selected commodities are subject to stabilisation schemes, where each scheme is of a different type, and where there is no coordination of price relationships between commodities, a set of such schemes could wreak havoc on the allocation of resources and create numerous problems of social justice. Consider, for example, the present set of levies—a tax of 2/2d. per bushel on wheat, a levy of $7\frac{1}{2}$ per cent. on the gross return from wool, and a tax equal to the difference between the guaranteed price and the export return per lb. of butter. An appreciation of the exchange rate would surely produce a more economic distribution of resources and give greater assurance of meeting criteria of social justice.

Stabilisation funds, whatever their value as countercyclical devices, cannot be expected to offset effectively inflationary influences induced as a result of exchange rate policy. For instance, it is unrealistic to expect any set of stabilisation schemes to compensate for the upward surge in wool and wheat prices which followed currency depreciation twelve months ago. The accumulation of stabilisation funds is not a sound long-term alternative to adjustment of exchange rates.

Anticipated Demands for Subsidies

The second possible justification for forced saving is anticipation by the government of political demands for subsidies in times of low wheat prices. The imposition of a system of self-financed subsidies may accordingly be regarded as a form of community protection against the political necessity of having to pay subsidies from consolidated revenue when prices are low.

Paternalism

A third justification for forced saving is sometimes set forth upon the assumption of the irrationality and ignorance of farmers. It may be argued that the characteristic behaviour of farmers whose returns are erratic is to spend when price and/or yield conditions give favourable incomes and to make no provision for depreciation or contingency reserves. This, it is felt, is irrational and is to be discouraged by government action both for the farmers' own welfare and for that of the economy.

The argument for paternalism may have still other manifestations. The tendency of farmers to make excessive and ill-advised investments and to borrow heavily in periods of favourable prices, together with the characteristic erratic movement of land values, is criticised as not redounding to the best interests of the farming industry. Similarly, in the depression phase of the business cycle, the damage done to human and land assets may be serious, if not irreparable. However, none of these arguments justify paternalistic restriction of individual

initiative and freedom, especially when confined to a limited group of industries.

Farmer Preference for Stability

A fourth conceivable reason for government intervention to stabilise returns hinges upon the demonstration that a majority of farmers prefer a stable known return to a fluctuating uncertain one. The wheat stabilisation scheme gives no guarantee that the returns will be stable, but simply that they will be more stable than in the absence of the scheme. Nothing in the scheme gives certainty as to price. The final blended price in any year is at present determined by the level of overseas prices, the aggregate yield and the movement of production costs. In any case there is no clear evidence that farmers have any predilection for stable prices instead of free market prices.

It should be noted that all four arguments in favour of forced savings are based upon the pessimistic presumption that extreme cyclical price behaviour will continue indefinitely. Sir Douglas Copland had cause recently to refer to the depression-oriented attitude of a large section of the Australian population and its negative effect on national development.[5] This is a fundamentally sound observation and applies as much to the general approach to agricultural price policy as to any other phase of our national life.

No one would deny the possibility of cyclical fluctuations in the future. However, there is no justification for perpetually preparing ourselves for another visitation of an economic depression of the magnitude of that of the early 'thirties. There is reason to believe that greater world economic stability can be achieved today than in the past by the intelligent use of known monetary and fiscal devices. This is true also of individual countries, though the accomplishment would be somewhat more difficult in the absence of parallel action by other countries.

2. GUARANTEED VERSUS MARKET PRICES FOR AGRICULTURAL PRODUCTS

The second major feature of stabilisation schemes is the advance guarantee of a price floor. It is arranged that the support will become operative when the stabilisation fund is exhausted. Such support in the case of wheat is to be paid on the first 100 million bushels exported. This is essentially an assurance of a future subsidy because exhaustion of the stabilisation fund would mean that market prices were below the guaranteed floor.

Reduction of Price Uncertainty.

The principal economic argument in favour of the advance guarantee of prices rests on the improvement in farm resources which comes from the elimination of price uncertainty. Prices known in advance of the commencement of production may mean, first, increased accuracy and certainty of producers' production plans, leading to more efficient production through elimination of misjudgments and reduction of the costs of maintaining flexibility; second, a more liberal credit policy on the part of lending institutions, thus facilitating greater efficiency of use of farm assets; and third, greater confidence on the part of farmers in investing in a particular enterprise.[6]

But the price support provisions of wheat stabilisation plans cannot be substantiated to any great extent upon the anticipation of such improvements in the use of resources. The scheme does not remove price uncertainty, but merely removes uncertainty about returns from the domestically consumed portion of the crop. Farmers do not know until long after the harvest what the return on their crop will be. The significance of the price guarantee for immediate farm planning is very limited, since returns at a much higher level than the guarantee can be

anticipated. Perhaps it might be relevant for a farmer undertaking middle-term investments such as investments in machinery, but it would be very misleading if used in short-term production planning.

Even if the price guarantees were of value to agricultural producers it is exceedingly difficult to justify treatment of this kind without applying it to all producers.

The question of the duration of any forward price guarantee should be mentioned at this point. Currently, the price guarantee in respect of both the wheat and dairy schemes is for five years. Neglecting here the problem of government financing of long-term guarantees, doubt must be raised from an economic standpoint as to the benefits that accrue to farmers from advance guarantees that extend beyond one, or at the most, two, production periods. The chances that market prices will diverge from the price guarantee are enhanced as the period of the guarantee is extended. Insofar as this occurs, the improvement in the efficiency of resources arising from the long-term guarantee, if any, must be weighed against the misdirection of resources arising from fixing an arbitrary price unrelated to market price movements.

The Case for a Subsidy

The case for outright subsidies to agriculture (as distinct from simply advance guarantees) is less clear-cut. It might be contended that if the low prices which give rise to a demand for subsidies are a concomitant of a depression, the appropriate remedy is fiscal measures, including, perhaps, general income payments rather than income payments restricted to farmers. On the other hand, if the unprofitable prices arise in the absence of a general depression (for instance, as a result of a long-term change in the conditions of demand) a long-term subsidy is not justified from an economic standpoint. Governments are, however, rarely prompted by purely economic considerations when deciding their policy on subsidies.

Producer Response to Depression

One justification for income payments to agricultural producers in depression arises from the competitive structure of agriculture *vis-a-vis* the rest of economy, and the typical response of agricultural producers to depressed prices. Instead of curtailing production when prices fall, farmers characteristically expand their output in order to sustain net income and meet fixed commitments.[3] Failure to maintain farm incomes by subsidy may therefore further the accumulation of surpluses. Moreover, insofar as depression in agriculture is reflected in low prices and under-employment rather than rigid prices and unemployment, there is reason for a special kind of assistance to agricultural producers.

Subsidies Help to Support Aggregate Demand

An argument can also be made on the ground that payment of subsidies to agriculture in time of depression helps to maintain the level of aggregate demand. This is true, but here again, why should agricultural groups be particularly favoured? In Australia, there are special considerations that might justify such partiality. As most inflationary and deflationary influences are received from abroad *via* agricultural prices, agricultural producers tend to suffer first and more seriously with the advent of a depression than do other groups in society, at least in the short run. Thus there might be reason to support agricultural incomes before general income payments become necessary, if ever they did. Prompt action on behalf of agricultural producers may limit the severity of a recession.

The fact that Australia depends on its agricultural industries for income from foreign trade also provides it with a good reason to sustain such industries in a viable condition during temporary phases of deficient demand in overseas markets. But this argument is used politically in support of subsidisation of uneconomic industries including those declining because they are outmoded, as well as in support of subsidies to those suffering from cyclical fluctuations.

It seems, therefore, that some form of subsidy to, say, wheat producers in a depression, may be economically justifiable. However, there appears to be no sound economic reason for giving an undertaking to carry through such a subsidy policy years in advance of its being necessary.

3. THE HOME CONSUMPTION PRICE

A third feature of stabilisation schemes is the practice of making available the product in question to the Australian consumer at a price equal to the guaranteed price. Within the last year or so, this phase of the programme has not been carried out according to plan. Actions by the Commonwealth Government and State price control authorities are tending to make the home consumption prices fixed rather than varying them in accordance with movements in production costs. The Commonwealth Government has paid consumer subsidies representing the difference between the home consumption prices and the guaranteed prices. In recent years the home consumption prices have been substantially below world parity. For a period, Australian consumers were getting wheat at approximately one-third of the export price. In the past three wheat pools, growers claim to have lost £40 million through concessional sales to Australian consumers.

The Principle of Reciprocity

First let us examine the home consumption price in relation to food items. Sundry explanations have been offered for the fixing of a domestic price independent of the export price. Most of them have a non-economic basis. It is argued, for instance, that the present wheat scheme is simply a perpetuation of the *quid pro quo* principle established in the 1938 wheat legislation, that the consumers would support the industry by paying a price in excess of world parity when the latter was low, but in return would pay the same price when export prices rose. The present scheme, at least in theory, provides for a varying instead of a steady price. A variant of this argument is to apply the *quid pro quo* principle in a forward direction, anticipating future subsidies.

The proponents of this argument rarely weigh the benefits and losses accruing to producers and consumers over time. Whether one examines the operation of this principle in a forward or backward direction, one cannot escape the conclusion that the consumer has received, and is likely to receive, benefits far in excess of those received by the farming community.

One Aspect of the General Economic Stabilisation Programme

When post-war stabilisation schemes for primary products were first framed, the Australian economy was in the throes of rigid price control. Administrators discovered that low home-consumption prices enforced by appropriate stabilisation legislation were, in the face of rapidly rising external prices, a useful auxiliary weapon to direct price control. In particular, as far as essential food items were concerned, home consumption price schemes could be used to keep the prices of several items in the cost-of-living index at more stable levels and thus limit the wage-price spiral operating through the basic wage system. Looked at in this sense, the home consumption price is a form of sectional taxation, in the interests of price control. Even with the relaxation of rigorous price control, the home consumption prices are still preserved in legislation.

The major effect of the pricing procedure is its relating of guaranteed prices to the internal cost situation and certain welfare standards, thus insulating the particular industry from the impact of variations in domestic and overseas demand. There is a limit to the degree to which a primary-producing country can afford to provide protection to its major export industries from the vagaries of world prices. Short-term fluctuation of prices could be eliminated with advantage. But longer term movements in prices on overseas markets reflecting changes in the conditions of supply and demand cannot be disregarded with impunity, especially by a country which normally exports two-thirds of its wheat crop. Market-determined prices are a powerful influence for transmitting such long-term changes to the domestic economy.

The present use of cost-of-production formulae containing wage elements linked to Arbitration Court awards (and their possible wider extension) could contribute substantially to the wage-price spiral in this country. If one considers the food elements of the basic wage regimen and the wage elements of a cost of production formula for an agricultural product, the spiralling potentialities of such formulae will be readily seen.

CONCLUSION

Measures to stabilise the income of the primary producer are desirable from an economic point of view if the social gains resulting from stabilisation efforts are greater than the social costs of implementing stabilisation policies.[1] I have suggested that, from a national standpoint, the gains to the community under schemes in vogue in this country are not commensurate with their costs. Moreover, serious inequities in social justice between the major classes of society are being perpetrated. The economic welfare of the farmer would appear to be one of the least considerations motivating the continuation of the present stabilisation schemes. They have become means to other political objectives such as:

(1) the supply of cheap food to domestic consumers;
(2) price control and action to meet the allegedly ever-threatening depression;
(3) procrastination in the matter of the appreciation of the exchange rate because of its politically dangerous repercussions;
(4) countering the detrimental effects of the basic wage system in an inflationary situation; and
(5) promises of future subsidies for party-political ends.

Insofar as agricultural prices are manipulated from the standpoint of these objectives, they are practically useless in guiding the agricultural resources of this country into economically desirable lines of production.

The foregoing examination of agricultural stabilisation measures has been essentially economic in nature. But public policy involves more than economic behaviour. Policy has to be considered within the whole framework of social, political and economic institutions and behaviour. What comes out of the melting pot of politics is rarely entirely rational nor what an economist would applaud from a narrow professional standpoint.

The goals of agricultural policy in the economic sphere should be threefold; first, the allocation of resources in such a fashion as to maximise the real income of society; second, the promotion of stability of agricultural prices and incomes; and third, the achievement of a level and distribution of income among persons that will result in the highest attainable level of social welfare.[7] The function of the price system is primarily concerned with the first objective—that of guiding production and marketing.[8] It cannot be used simultaneously to achieve the other two ends. Social wel-

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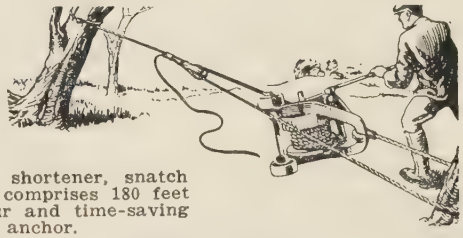

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fare objectives involving transfers of income between the various sectors of the community should be carried out by direct subsidies rather than by arbitrary price adjustments.

For the promotion of economic stability major reliance must be placed upon the monetary and fiscal management of the government and this need not involve manipulation of agricultural prices. Moreover, income instability in Australian agriculture is as much a product of instability of production as of instability of prices. The former matter is at present untouched on a governmental plane. It is worthy of the most urgent attention by those who have the welfare of the farmer at heart.

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RECENT ADVANCES IN FRUIT JUICE PRODUCTION

By V. L. S. CHARLEY and OTHERS

(*Commonwealth Bureau of Horticulture and Plantation Crops Technical Communication No.* 21, 1950, *pp.* 176. *Obtainable from technical bookshops or from the C.A.B. Liaison Officer,* 314 *Albert Street, East Melbourne,* C.2. *Price* 18/9.)

Concurrently with the large increase in the consumption of fruit juices in recent years great advances have been made in the methods of commercial preparation. The latest developments and the procedures used in American, European and British Commonwealth countries are discussed in this copiously illustrated book from the Bureau of Horticulture and Plantation Crops.

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Prepared by a team of experts from British countries the book provides an authoritative review of all aspects of modern fruit juice technology.

LOW-VOLUME D.D.T. SPRAY TREATMENT OF A LUCERNE SEED CROP

By N. E. GRYLLS

Introduction

Several leaf and flower eating caterpillars and leafhoppers are important pests of lucerne grown for seed in Australia[12, 8, 3]. D.D.T. has shown considerable promise overseas and in Australia in controlling some of these pests on this and other crops. There is substantial evidence that the leafhopper *Orosius argentatus* (Evans), is a vector of virus diseases in Australia[6, 7, 4], and Helson[5] showed that this insect is able to transmit witches' broom of lucerne from lucerne to other plants. It seemed worthwhile to test low-volume, low-pressure D.D.T. sprays against *Orosius argentatus* and the opportunity was also taken to observe the effect of D.D.T. on other pests including *Heliothis armigera,* Hb., lycaenid larvae, loopers, and various species of leafhoppers. The following experiment was carried out during the late summer of 1949-50.

Experimental Procedure

A twenty-acre area of lucerne at Canowindra, New South Wales, about twenty years old, was divided into twenty plots in a conventional randomized block design, which allowed five replications of four treatments. Plots were separated by a mower cut three feet wide. Emulsions containing 0.1, 0.5 and 3 per cent. p,p-isomer D.D.T. were applied at the rate of 4 gal. per acre, by means of a "Lovol" low-volume low-pressure spray machine mounted on the rear of a jeep, and operated from the power-take-off. The speed of the jeep was governed so that the machine developed a pressure of 25 lb. per sq. in. and delivered 4 gal. per acre uniformly through ten tee-jet nozzles of 0.032 in. aperture spaced equally along a 14 ft. boom.

Insects were sampled before the initial treatment and twenty-four and forty-eight hours after the first; and also before and forty-eight hours after the second treatment. The treatments were applied just prior to flowering and three weeks later when most of the blossom had set. Insect populations were sampled by making standard sweeps over the central portion of each block leaving a 30 feet border around each to act as a buffer against spray drift and insect migration. Two hundred sweeps were taken on each block using a 14 in. diameter organdie net and the results of the D.D.T. treatments on insect density is shown in Table I. Comparisons should be made between treatments at the same date, for between times of sampling the effect is obscured by changes from other causes and by changes in the activity of the insects. Each D.D.T. treatment significantly reduced the numbers of all the insect species studied, except the minor species of leafhoppers. Untreated plots were easily recognised in the field because of the un-

N. E. GRYLLS, D.D.A., is a Technical Officer of the Commonwealth Scientific and Industrial Research Organization, Division of Entomology and is stationed at Canberra, A.C.T.

TABLE I

Results of D.D.T. Spraying on Lucerne Insects

Numbers of insects refer to catch per 200 standard hand sweeps

Sampling time	Treatment	Lycaenid larvae	*Heliothis armigera* larvae	Loopers	*Orosius argentatus*	*Empoasca* species	*Thamnotettix* species	Other leafhoppers†
Pre-spray	Untreated control	23	13	3	169	758	31	27
	0.1% D.D.T. ..	45	20	9	233	1102	30	37
	0.5% D.D.T. ..	28	13	0	155	685	27	41
	3.0% D.D.T. ..	61	30	5	213	1245	77	55
24 hours Post spray	Untreated control	21	4	5	103	717	12	9
	0.1% D.D.T. ..	28	6	2	79	321	24	18
	0.5% D.D.T. ..	22	0	3	42	68	15	20
	3.0% D.D.T. ..	21	0	2	14	17	7	8
48 hours Post spray	Untreated control	49	2	5	130	630	9	37
	0.1% D.D.T. ..	79	7	24	76	184	6	32
	0.5% D.D.T. ..	27	2	12	37	38	6	29
	3.0% D.D.T. ..	21	0	4	21	8	5	13
Pre 2nd spray	Untreated control	220	266	110	46	330	8	14
	0.1% D.D.T. ..	162	302	130	32	154	2	6
	0.5% D.D.T. ..	138	220	130	36	16	8	0
*	3.0% D.D.T. ..	60	58	106	26	8	6	10
48 hours Post 2nd spray ..	Untreated control	166	126	92	56	1200	6	10
	0.1% D.D.T. ..	160	76	60	26	328	20	10
	0.5% D.D.T. ..	84	22	14	12	28	10	12
	3.0% D.D.T. ..	18	4	4	0	0	0	2

*Rain fell on February 15 and the 24 hours Post 2nd spray sweeps could not be taken.

†Species in this column include *Eurinoscopus punctatus* (Evans), *Nesoclutha obscura* (Evans), *Balclutha* sp., *Erythroneura* sp., *Euscelis* sp.

healthy appearance of the lucerne and the marked reduction of seed pods.

Heavy rains fell during the season, 4.45 in. being recorded on the property over the period between the application of the two sprays. Vigorous regrowth followed the heavy rains and the relatively poor set of seed and heavy plant growth led to the abandonment of the crop for seed production by the grower, who then wished to use the area for grazing. At this stage the seed was still immature and it is possible that a third spraying would have helped to protect the seed had it been allowed to ripen.

Seed Sampling Methods

Unsatisfactory as the conditions were, it was considered desirable to have some measure of the effects of the sprays on seed production. Facilities were not available for cutting and threshing an adequate sample area from each plot. Instead, standards were chosen (Fig. 1) to give a scale of seed production per mature stem and single handfuls at each of seventy-five positions in each plot were assigned a rating in terms of this scale. Representative samples of mature stems were collected from each treatment for all ratings present on the treatment and for each such class the mean weight of seed per stem was determined. There was no evidence that for a given rating the weight of seed per stem varied with the rate of D.D.T. applied so a mean of seed per stem based on all treatments was determined for each rating.

The ratings and corresponding weights of seed per stem were plotted and a smooth curve, which departed only slightly from the points, was drawn through them. The corrected equivalents of weights per stem were then used to

Figure 1.

Examples of Ratings 0-5 as used in the Field for Estimation of Seed Yields.

Each rating is made up of eight lucerne stalks. Note the progressive increase in pod numbers and the better distribution over the stems. Rating 5 was estimated by the grower as giving approximaely half the yield of a good commercial crop for the Canowindra district.

convert the individual field ratings to weight per stem.

Effect of D.D.T. Sprays on Lucerne Seed Production

Table II shows the mean rating, the mean yield per mature stem and the relative yields between the unsprayed controls and the various spray concentrations. All differences between mean ratings are significant at the 5 per cent. level at least.

TABLE II

Effect of Sprays on Seed Production

D.D.T. Spray Concentration (p,p-isomer)	Mean Rating	Mean yield/ mature stem (mg.)	Relative yields
Nil	1.928	188	100.0
0.1%	2.397	246	130.4
0.5%	2.851	309	164.3
3.0%	3.192	364	193.1

Minimum difference in mean rating for significance:—
1 per cent. level: 0 476, 5 per cent. level: 0.340.

Discussion

The results obtained in this experiment not only support the evidence that D.D.T. will effectively control several of the most important lucerne pests, but indicate that a low-volume, low-pressure spray may be the most economical method of applying D.D.T. to a lucerne crop. The market price of lucerne seed is such than even when D.D.T. is applied at 3 per cent. concentration, the cost of materials and of application constitutes a very small proportion of the additional return gained. The potential danger of D.D.T. sprays to bees[1, 9], and to stock eating treated hay is not considered to be great. High residues on the treated hay may accumulate in milk and meat products[10, 11, 2]. Hence, it would seem desirable to apply the least amount of D.D.T. compatible with an efficient control of pests and significant increase in yield. This work suggests that a concentration between 0.5 per cent. and 3 per cent. at 4 gals. per acre would be practicable for general lucerne field treatment.

Acknowledgments

The author is indebted to Mr. A. Sergeant, Manager of Belabula Farms, Canowindra, N.S.W., on whose property the above work was carried out, for his unstinted co-operation, and to Mr. S. G. Sergeant for assistance in the application of the sprays; also to Mr. G. A. McIntyre, Section of Mathematical Statistics, C.S.I.R.O., who was responsible for the statistical analysis of the results and assisted with the planning of the work. The assistance of my colleagues of C.S.I.R.O. in the preparation of the manuscript is also appreciated.

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THE EFFECT OF BLACK-ROOT-ROT ON GROWTH OF SEEDLINGS OF FOUR VARIETIES OF TOBACCO

Introduction

The first report of black-root-rot of tobacco in Australia was made in 1927 by Mandelson[4] who recorded the presence of the organism, now known as *Thielaviopsis basicola* (Berk.) Ferraris, on roots of tobacco plants grown in several areas of New South Wales. More recently black-root-rot has been observed in tobacco seedbeds and fields in Victoria where soil temperatures early in the growing season are usually favourable for the development of the disease. Satisfactory and practical control of the disease has been obtained in North America and Europe by the use of resistant varieties whereas Hickory Pryor, the variety grown in Victoria, appears to be particularly susceptible to black-root-rot. This conclusion was supported by results obtained in greenhouse experiments, reported herein, in which the growth of Hickory Pryor seedlings was compared with that of three resistant varieties. The varieties were KY 41 A, a Burley tobacco from Kentucky, U.S.A.[6], and two flue-cured tobaccos—Yellow Special from North Carolina, U.S.A.[1] and Harrison's Special 215 from New Zealand[5].

Method

Small seedlings grown in sterilised soil in the greenhouse at Canberra, A.C.T., were transplanted into cans set in Wisconsin constant temperature tanks[3] maintained at 20°C.±2°. The soil had been steam sterilised and subsequently inoculated, as required, with soil from infested tobacco seedbeds. To ensure thorough infestation of the soil by the organism, seedlings of the susceptible variety Hickory Pryor were grown in the cans for a period of eight weeks. Soil reaction was approximately pH 7.0.

In the first experiment, in 1948, ten plants of each of the four varieties were grown in each of six cans randomized in the tanks. After twenty-nine days the plants were harvested by cutting them off just above ground level. Each individual plant was weighed and the statistically analysed results are summarised in Table I. On examination, the roots showed typical black-root-rot lesions, the presence of the causal organism being confirmed by isolation on carrot discs[7, 2] from both roots and soil. In 1949 the experiment was repeated using half of the original cans of soil, the remainder being filled with disease-free soil. Thus ten plants of each of the four varieties were grown in each of three disease-infested cans and in each of three disease-free cans. At forty-two days after transplanting, when the growth of the most resistant variety in disease-infested soil was similar to that obtained at the conclusion of the first experiment, each plant of all the treatments was weighed as before and the results are summarized in Table I. The presence of the disease and of the causal organism was again con-

TABLE I

Mean weight in grams of lots of ten seedlings of four varieties of tobacco grown in black-root-rot-infested soil and in disease-free soil.

VARIETY	1948		1949			
	Disease-infested soil		Disease-free soil		Disease-infested soil	
	Mean of Lots of 10 Seedlings		Mean of Lots of 10 Seedlings		Mean of Lots of 10 Seedlings	
	Weight (gm.)	Weights transformed as sq. roots	Weight (gm.)	Weights transformed as sq. roots	Weight (gm.)	Weights transformed as sq. roots
KY 41 A	228.9	14.8	255.0	15.9	224.6	14.9
Yellow Special	227.0	14.9	248.0	15.7	117.0	10.7
Harrison's Special	201.9	14.0	244.7	15.6	85.3	9.2
Hickory Pryor	69.5	8.0	248.0	15.8	36.0	5.9

The minimum difference for significance at the 5% level for the transformed values is 1.9.

firmed by examination of roots of plants grown in infested soil.

Results

In these experiments conditions were highly favourable for the development of black-root-rot in seedlings grown in infested soil. In the first experiment, when the plants were harvested after twenty-nine days, the three resistant varieties grew equally well but the yield from the Hickory Pryor plants was low. Under the longer growth period of forty-two days in the second experiment, due in part to much lower greenhouse temperatures, differences between varieties were apparent, but again the lowest yield was obtained from Hickory Pryor. There was no significant difference between varieties in the absence of disease.

Conclusions

From these experiments it is concluded that Hickory Pryor is highly susceptible to black-root-rot. KY 41 A is the most resistant of the varieties tested, while Yellow Special and Harrison's Special 215 are less resistant but could be expected to be much less affected by the disease, under field conditions, than Hickory Pryor.

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COUNCIL PROCEEDINGS

October Meeting

The 110th Meeting of Council was held at C.S.I.R.O., Canberra, on Tuesday, 3rd October, 1950, at 7.30 p.m.

Present

Dr. T. A. Harrison (in Chair); Mr. E. M. Hutton (N.S.W.); Mr. C. G. Greenham (Qld.); Mr. R. D. Brock (A.C.T.); Mr. C. H. Williams (S.A.); Dr. I. Molnar (Vic.); Mr. A. V. Hill (Hon. General Treasurer); Mr. G. A. McIntyre (Hon. General Secretary).

Apologies from Mr. F. O. Grogan and Dr. C. Barnard were received: Mr. E. M. Hutton acted as alternative proxy for Mr. C. M. Donald.

Salaries and Status

No advice has yet been received from the Melbourne Appointments' Board concerning the results of the recent survey but it is hoped that a report will be available for next meeting of Council.

Rural Extension Service

The South Australian Branch has supplied the information necessary to complete the summary schedule for this State. Similar information from other States is awaited.

Agricultural Engineering

The Secretary reported that the Victorian Sub-Committee report had been distributed to the Branches a fortnight before the meeting and that some Branches had not yet had an opportunity to discuss the recommendations. It was decided to defer action until the views of the other Branches are received and in the meantime to examine the suggestion of the N.S.W. Branch that the Sydney University of Technology may be interested in Agricultural Engineering as an option in its engineering course.

Interchange of Personnel

No reply has yet been received from the Prime Minister. One of the members of Proxy Council undertook to try and hasten the matter.

At the Premiers' Conference, Mr. Playford proposed that the agreement not to encroach on personnel in other State services should be extended to such schemes as the Snowy River development. Mr. Hanlon protested at the inducement offered to State men to join the Federal service.

Members of Proxy Council considered that a press statement was desirable and a draft letter was sent to the President for his approval, which was given. The letter, which was distributed to the leading papers in each State, was published only in the Adelaide Advertiser and Brisbane Courier Mail. The Sydney Morning Herald, on date of receipt of our letter, interviewed the Secretary of the Institute of Engineers, who expressed opinions identical with those of our Institute.

Institute Scholarships

Comments on the Council Sub-Committee interim report were received from Branches. It was resolved on the motion of R. D. Brock and C. M. Hutton:—

"That the interim report be endorsed and action be taken

(a) to ascertain if taxation reimbursement will be granted;
(b) to finalize details of the scheme which will be presented at the General Meeting at Brisbane with a view to its inauguration immediately afterwards."

By that time the following issues should be settled:—

(a) whether scholarships should be restricted to members of the Institute;
(b) whether the amount, duration and purpose of the scholarships should be closely defined;
(c) the nature of the machinery for organising the collection and distribution of funds;
(d) the general policy with respect to accumulation of funds;
(e) the form of acknowledgment to principal donors.

Abstracting Service

It was resolved "That Council considered the provision of an abstracting section in the Journal is unnecessary."

Agenda for the General Meeting, Brisbane

Other than the suggestion for the inauguration of the Scholarship Scheme and the possibility that the course of action with respect to Agricultural engineering will have to be settled at a General Meeting, no additional suggestions for Agenda items have been received.

Subscriptions of Overseas Members

The South Australian Branch proposal for waiving subscriptions of members overseas was circulated to Branches for consideration. Western Australia, Queensland and Australian Capital Territory were not in favour of alteration to the present rules. Victoria was in favour of the South Australian motion. New South Wales submitted the following amendment:—

"On receiving notice that a Branch member will be in any territory outside those covered by the current A.I.A.S. Branches for the purpose of studying at educational or research institutions, provided that the member's subscriptions and other commitments to the Institute are fully paid, the Branch Treasurer shall automatically waive the normal subscription for the period of absence of the member providing such period is longer than twelve months. At the end of two years, if the member is still outside any Institute Branch area, the Branch Treasurer will bring the case before Council, where it will be considered on its merits."

The member, of course, would retain full membership rights and receive the Journal.

The amendment was carried and as it now stands or in a modified form it will have to be presented at a General Meeting for incorporation into the constitution.

Membership

ADMISSIONS

With the recommendations of the Branch submitting the applications and the Qualifications' Committee, the following applicants were admitted to **Corporate Membership.**

Miss C. E. Edwards, Vic.
J. K. Gaunt, Vic.
W. J. Bisset, Qld.
R. F. Moore, Qld.
J. R. Harris, S.A.
A. P. Kennedy, N.S.W.
H. N. Barber, Tas.

The following applicant was admitted to **Student Membership** on the recommendation of the Branch submitting the application.—

R. N. Sandiford, N.S.W.

RESIGNATION

The resignation of Dr. D. B. Duncan, who is now Associate Professor of Statistical Methods at Virginia, was accepted with regret.

TRANSFERS

The following transfers were noted:—

G. S. Purss—N.S.W. to Queensland
J. Tesch—Victoria to Queensland
D. S. Jones—A.C.T. to New South Wales

OVERSEAS MEMBERS

On the motion of C. H. Williams and R. D. Brock it was resolved:—

"That the subscriptions of F. C. Butler (N.S.W.) and D. B. Halloway (S.A.) be waived during their absence abroad in the tenure of research scholarships."

Institute Publicity

A copy of the Argus Royal Show supplement again contributed to by the members of the Victorian Branch of the Institute was circulated among members of Proxy Council, who expressed their strong approval of this well-timed publicity.

BRANCH NOTES

Australian Capital Territory

A general meeting of the Branch was held on August 24, when Dr. A. J. Nicholson, Chief of the C.S.I.R.O. Division of Entomology, delivered an address entitled "An Outline of Population Problems."

A general meeting of the Branch was held on October 9, when Mr. M. Hutton, Officer-in-Charge of Genetics of Disease Resistance Section of the C.S.I.R.O., Division of Plant Industry, gave an address entitled "The Nature of Plant Viruses."

New South Wales

At a general meeting held on June 29, 1950, the main business was a symposium on "The control of quality in processing fruits and vegetables." The three speakers were Mr. S. M. Sykes, Fruit Research Officer of the N.S.W. Department of Agriculture, Mr. R. S. Mitchell, Research Officer of C.S.I.R.O., Division of Food Preservation and Transport, and Dr. V. M. Lewis, a Sydney food technologist.

Mr. Sykes discussed the importance of varietal and environmental factors in relation to the quality of the finished product. The requirements of varieties for different processes (e.g., canning, quick freezing and dehydration) are not necessarily the same and plant breeders have now developed many types suited to a particular purpose. Again, the quality of the processed food can be affected by the growing conditions and cultural practices in the field. Many problems which at first might appear to be the concern of the processor can best be solved by closer attention to the growing crop.

The second speaker, Mr. Mitchell, dealt with the measurement of maturity in crops for processing. Fruits and vegetables must be canned, dried or frozen at the stage of maturity which best suits the product. The time of maturity is critical for peas and sweet corn and many different methods have been developed for both predicting and measuring the stage of maturity of these crops. The need for close liaison between field and factory was stressed.

Dr. Lewis showed how the processor is able to control quality in the processing plant. Using peas as an example, he described the essential steps in the canning and quick freezing operations. The processor influences quality throughout the various operations by checking of such points as viner speed, handling of raw material, blanching, quality grading, heat processing and quick freezing.

On September 4, a general meeting was held in the Conference Room of the Rural Bank of N.S.W. The main speaker was Dr. Keith O. Campbell, and the text of his address on "Economic Aspects of Agricultural Stabilisation Schemes" is published elsewhere in this journal.

South Australia

At its general meeting held on September 7, 1950, the South Australian Branch was addressed by Mr. A. L. Royal, a member of the Advisory Board of Agriculture, on the subject "Some present-day Agricultural Problems as seen by a Practical Farmer."

Victoria

Members of the Branch took part in the preparation of articles for a supplement to "The Argus" appearing at the time of the Royal Show. The articles gave prominence to the development of agriculture in this State and the present-day outlook of the scientist on agricultural matters.

The Annual Dinner was held on September 26 at the William Angliss Food Trades School, under the personal supervision of the international celebrity, Chef Zimmerman. This annual event again proved a great success and was attended by over eighty members and guests.

On September 8, Mr. J. K. Gaunt, B.Agr.Sc. (Leeds), Engineering Superintendent of H. V. McKay Massey-Harris, gave an address entitled "Training and scope for agricultural engineers."

Dr. F. Loewe, Senior Lecturer in Meteorology, University of Melbourne, gave an address to the Branch on October 6, entitled "Some aspects of microclimatology."

Western Australia

An ordinary general meeting of the W.A. Branch was held on August 3, when a joint symposium was delivered on "Twentieth Century Agriculture—Past Achievements and Future Trends."

Dr. G. L. Sutton, Commissioner for the Wheat Belt from 1911 until 1921 and Director of Agriculture (W.A.) from 1921 to 1937, spoke of the Past Achievements, and Mr. R. P. Roberts, Economic Adviser (Department of Agriculture), spoke on the Future Trends within Western Australia.

At an ordinary general meeting of the W.A. Branch held on August 24, Dr. C. G. Stevens, Senior Principal Research Officer, Division of Soils, C.S.I.R.O., Waite Institute, spoke on "What Soil Science and Pedology Encompasses."

He outlined the modern approach to the study of soils and explained how the various natural processes of weathering and leaching, etc., acting on parent materials, resulted in soil formation.

The second phase of the address dealt with soil classification and its relation to land use. This was supplemented with lantern slides of soil types studied during the speaker's recent trip abroad to Europe and the U.S.A.

PERSONAL

Australian Capital Territory

Mr. P. A. Reid, Chief Research Officer (Wool) of the Bureau of Agricultural Economics, has returned to Australia after visiting South Africa, the United Kingdom and the United States.

New South Wales

Miss Helen Wrigley, a former secretary of the New South Wales Branch, has resigned from the New South Wales Department of Agriculture to join the National Press Pty. Ltd., as Editorial Assistant.

Mr. K. Watson has joined the British Colonial Agricultural Service. After a period of about two years at Cambridge he will be appointed to one of the Colonies.

Miss Alison Kingsland is now in England continuing her studies in agricul-

tural economics. She was previously attached to the Division of Marketing and Agricultural Economics of the New South Wales Department of Agriculture.

Mr. P. Baxter, a recent graduate of Melbourne University, has been appointed a Research Officer of the Division of Plant Industry, C.S.I.R.O., at the Regional Pastoral Laboratory, Armidale.

Mr. I. L. Johnstone, Officer-in-Charge of the C.S.I.R.O. Regional Pastoral Laboratory, Armidale, has been appointed Primary Industry Officer to the Australian Scientific Liaison Office, London.

Mr. R. Roe has been appointed Acting Officer-in-Charge of the C.S.I.R.O. Regional Pastoral Laboratory, Armidale, during Mr. Johnstone's absence abroad.

Queensland

Mr. A. F. Bell, Under Secretary, Department of Agriculture and Stock and Deputy Chairman of the Bureau of Investigation, has been appointed a member of the Royal Commission on Pastoral Lands Settlement (Queensland).

Mr. J. H. Buzacott, Senior Plant Breeder, Bureau of Sugar Experiment Stations and *Mr. C. G. Hughes,* President of the Queensland Branch of the Institute and Pathologist, Bureau of Sugar Experiment Stations, are shortly to leave for New Guinea to search for new canes for use in cane breeding work.

Within the Queensland Department of Agriculture and Stock *Mr. D. O. Atherton* has been appointed Director of Agriculture, and *Mr. W. J. S. Sloan,* Assistant Director of Agriculture, while *Mr. L. E. Nichols* has taken over the duties of Director of Dairy Research.

Mr. C. T. White, late Government Botanist and a former member of the Institute, who was well known to Institute Members, died suddenly on August 16, 1950. The University of Queensland conferred the honorary degree of Master of Science on Mr. White, and in 1946, he was awarded the Mueller Memorial Medal by the Australian and New Zealand Association for the Advancement of Science.

South Australia

Mr. H. P. C. Trumble has accepted an appointment as Citrus Research Officer, Horticultural Branch of the South Australian Department of Agriculture.

Mr. B. W. Holloway recently left for America to take up a Fellowship awarded him by the Californian Institute of Technology.

Mr. A. J. K. Walker has resigned from the Waite Institute and accepted an appointment in the South Australian Department of Agriculture as Senior Research Officer in Agronomy.

Mr. J. P. Quirk has been granted a studentship by C.S.I.R.O. He proposes spending the greater part of his time at Rothamstead.

Mr. R. W. Jessup, former Senior Lecturer in Agronomy at the Waite Institute, has been appointed Pasture Ecologist with the Division of Plant Industry, C.S.I.R.O., at the Regional Pastoral Laboratory, Armidale, N.S.W.

Victoria

Mr. F. M. Read has been appointed Superintendent of Horticulture in the Victorian Department of Agriculture. He succeeds Mr. J. M. Ward, who retired last June.

Mr. Colin Cole has taken Mr. Read's former position as Senior Inspector of Horticulture.

Mr. Frank Penman has resigned from the State Rivers and Water Supply Commission to take up the position of Officer-in-Charge, C.S.I.R.O. Research Station, Merbein.

Mr. P. F. Marriott resigned from the Department of Agriculture recently to take up a soldier settlement holding.

Western Australia

Mr. R. A. Paul, formerly Assistant Superintendent of Dairying in the Western Australian Department of Agriculture, has resigned to take up a position as Director of Field Services, Division of Dairying, Queensland Department of Agriculture and Stock.

REVIEWS

THE GENETICS OF THE FOWL

By F. B. HUTT

(McGraw-Hill Book Company Inc., New York, U.S.A. Angus and Robertson, Sydney, 1949. 69/6.)

Professor Hutt, of Cornell University, U.S.A., is the author of numerous papers on genetics, including a chromosome map for the domestic fowl. He is therefore well qualified to write on this subject.

Seventy-two major genes are listed in this book and their effects are discussed. Unfortunately only a few of these genes are related to economic characters, because quantitative characters, such as egg-yield, are controlled by polygenes.

The subdivision of this book is unusual, as the author has treated a very complex subject in eleven chapters under headings dealing with variations affecting the different parts of the body and different physiological characters. There is also a chapter on Linkage and one on Genetics in Practice. The author's very balanced views should form a valuable guide to breeders; for instance, the section where he shows what mass selection can do and when progeny testing has to take its place. It is a pity that all reference to the modern theory of population genetics is omitted except where the author states that "the existing techniques for analysing characters dependant upon multiple factors are hardly adequate to warrant even an estimate."

The publication is not an introduction to genetics, nor is it primarily a textbook on the practice and theory of poultry breeding. It is a book on the genes of the fowl, containing all the widely-scattered information on this subject, and as such it should be valuable to animal geneticists, poultry breeders, students and teachers.

The book is made still more valuable by an impressive bibliography, a chart of all the symbols for the genes of the fowl, and a glossary with definitions of genetical terms.

F. SKALLER.

THE WESTERN RANGE LIVESTOCK INDUSTRY

By MARION CLAWSON

(McGraw-Hill Book Company, New York, 1950. pp. 401, Price $5.00)

To one familiar with livestock production, as such, for upwards of forty years, reading this book is like peeping behind the mirror. Incidentally the author, Marion Clawson, is a man. He states that the book is designed primarily as a college text and that its objective is "to analyse and describe the range livestock industry from an economic viewpoint." To fulfill his purpose the author has presented the material, which is essentially technical, in a strong theoretical framework. Thus when discussing Ranch Values and Income in Chapter XVII he states that Rent is the price paid for the services of land. The rancher must pay for the labour he hires and the goods he buys. He expects for himself a reasonable return for his own labour and management and for his investment in livestock. Income beyond this is usually attributed to the ranch property. In the economists' terminology such income is rent. Rent differs greatly from wages and interest in one important respect: wages induce labourers to work and interest induces people to save and invest but nothing needs to be paid to the land itself as an inducement to grow plants. Had his several landlords been fully aware of these concepts the reviewer's experiences with leased properties would probably have been much happier.

Material in the book is restricted to ranching in the United States of America. Range land is defined as that which, because of low rainfall or other adverse climatic conditions, cannot be used for any other form of agriculture and where native forage plants and grasses are never fertilised or cultivated. Such lands are used predominantly for the maintenance of sheep or beef cattle. One of the author's few internationally based comments is made when comparing the temperate grasslands with tropical grasslands and savannahs. He states that the latter have not been fully or entirely successfully used as yet, that the grasses grow rank and coarse becoming nearly inedible during the long hot dry season and that, in addition to the unfavourable heat, the savannahs harbour several serious diseases and insects. Those familiar with conditions in Northern Australia might well regard the foregoing as being almost under-statements.

When discussing the climate of the range region, and particularly the variability of rainfall, the author introduces the "coefvs" as a new measure which combines the conception of sequence with that of variability. The full name of the measure is stated as "the coefficient of variability sequence." This measure was evolved by the author who gives the reference **Journal of Land and Public Utility Economics 23**: 3 pp 271-287 (1947) for its expounding. It is designed to disclose whether all the wet years occurred in one sequence, all the dry ones in another or whether they alternated perfectly. It is considered to be a measure of "bunching up" or alternation. He classifies various range regions as having similar "coefvs" described as high or low and associated with appropriate but different types of range management. Probably the new measure could be gainfully employed in Australian surveys of land utilisation where sufficient records are available.

Although the text has the theoretical framework which has been noted, it contains some statements of general and practical interest. For example, it is common knowledge that American railway companies were induced to build railroads through range areas by giving the companies grants of land along the proposed route. It is of interest to learn, however, that the grants involved 126 million acres in a total of 728 million acres of range and i.e. approximately 16 per cent of the total. One wonders whether such a generous policy would be equally stimulating in Australia. It is also learnt that, in the United States of America, beef cattle on the ranges are not expected to travel more than three miles to water. Readers of the book need not expect to find many such statements. Its design as to economics has been very faithfully carried out. Its greatest use in Australia will be to students and those working in Agricultural Economics who wish to learn the principles which govern the making of such surveys in the United States of America

R. B. KELLEY.

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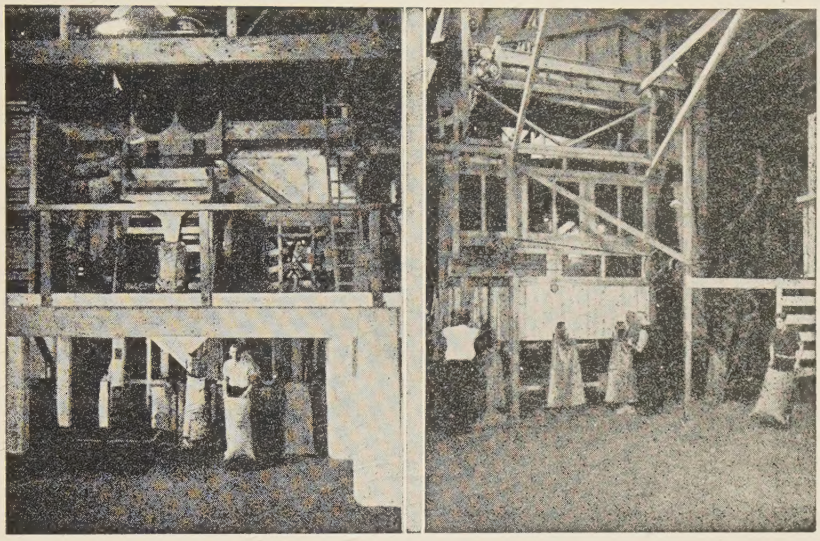

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